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An Obsession Matched Intervention Improves the Facial/Emotional Recognition Deficit in Children with Asperger's Syndrome

A Senior Project submitted to

The Division of Science, Mathematics, and Computing

of Bard College

By

Aurora Hoffman

Annandale-on-Hudson, New York

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Abstract

Asperger's Syndrome (AS) falls on the high-functioning end of the Autism Spectrum. AS is often characterized by a deficit in social/emotional/facial processing, resistance to change, and routine and repetitive behaviors and interests. Prior research has uncovered that AS individuals process faces in a detail-oriented piecemeal fashion, rather than holistically. They are also found to pay less visual attention to faces and social stimuli. Theoretical explanations that account for this particular functioning and processing style include Weak Central Coherence Theory (WCC) and Hyper-Systemizing Theory. WCC implies that AS individuals do not process instances within context, which contributes to their inability to process many aspects involved with socialization. Hyper-Systemizing Theory implies that AS individuals have a systemization mechanism that is set too high. This hyper-systemization lends itself to a reliance upon predictable systems, which leaves no room for the unpredictable and highly variable nature of socialization. AS individuals also demonstrate devout attention and obsession-like qualities towards their specific object of interest. The content of their obsession often falls under the domain of folk physics: an interest and understanding in how the physical world works. All of these qualities suggest the need for an individualized facial/emotional recognition intervention. Implications regarding well-being and daily functioning are discussed. This study proposes that an obsession-matched intervention will improve AS participant's scores on a facial/emotional recognition test (Cambridge Mindreading Face-Voice Battery Test for Children [CAM-C]), as well as capture their attention. Participants include 80 AS male children between the ages of 6 and 11, who are obsessed with either clocks or trains. Participants view either an obsession-specific intervention or a non-obsession specific intervention, once a week, for 16 weeks. Eye-tracking technology is used during viewing periods to capture their fixation durations, which is quantified as attention. This intervention is an altered version of the highly efficient "The Transporters" intervention (Baron-Cohen, Golan, & Ashwin, 2009). Scores on the CAM-C are recorded pre and post intervention viewing period**.** Proposed results reveal that participants who were in the obsession-specific intervention had significantly higher post intervention CAM-C scores, than their pre intervention scores ($p<0.05$). They are proposed to also have significantly higher post-intervention CAM-C scores than participants in the non-obsession specific condition ($p<0.05$). Proposed results also indicate that participants in the obsession-specific condition paid significantly more attention to the intervention ($p<0.05$), via their fixation durations. These proposed findings demonstrate the need for, and benefits of, individualized obsession-specific facial/emotional recognition interventions for AS children. Furthermore, these benefits are proposed to aid the development of social functions and relationships for AS individuals into adulthood. Further implications and limitations are discussed.

Key words: autism, asperger's syndrome, intervention, obsessions, circumscribed interests, facial recognition, emotion recognition, socialization.

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Introduction

Asperger's Syndrome and Autism Spectrum Disorder

Autism Spectrum Disorder (ASD) is a chronic mental disorder that is comprised of behaviors and processes that fall on a spectrum. ASD is defined by the DSM-V (2013) 5th ed. in part by a qualitative impairment in social interaction (American Psychiatric Association, 2013). This manifests in a lack of social emotion or reciprocity, failure to develop peer relationships, appropriate and developmental relationships, and failure to utilize nonverbal behaviors to communicate. Another aspect of the disorder described by the DSM-V involves restrict, repetitive, and stereotyped behavioral patterns. This is exemplified with an immense preoccupation, or an abnormal intense focus on, restricted patterns of interests. Individuals with ASD also have inflexible adherence to precise yet nonfunctional routines or rituals, often observed in their stereotyped motor tendencies.

Often referred to as High Functioning Autism (HFA), Asperger's Syndrome (AS) falls on the autism spectrum as well. Although HFA falls on the same part of the autism spectrum as AS, the two differentiate by the absence and/or presence of specific categorical symptoms. Asperger's is defined by the DSM-V as similar to ASD in all assets, aside from a delay in cognitive and language development. In other words, individuals diagnosed with AS differentiate from the rest of those on the spectrum, and HFA, with regards to their language abilities and their abilities to care for themselves. They are fully cognitive, aware, capable, and fluent in whatever their first language is. In addition, their IQs are often above average and superior levels (American Psychiatric Association, 2013).

For the sake of continuity, this study will cite prior literature that investigates Autism Spectrum Disorder, High Functioning Autism, as well as Asperger's Syndrome. Individuals on the autism spectrum, but without Asperger's, do have other deficits than just this social/emotional/facial deficit (American Psychiatric Association, 2013). Studies that detail the additional deficits characteristic of ASD will not be included in the literature review for this study, as they do not pertain to the specific deficit and/or population that this study investigates. Not only will the referenced studies focus on one or the other, or both of these two syndromes; they will also pertain to the nature of the social/emotional/facial deficit that is observed within these three populations. Furthermore, referenced literature in this study will also pertain to and contain a variety of ASD/HFA/AS age groups. These studies are included due to a lack of much change in symptomatology throughout the lifespan of an ASD individuals (Taylor, & Seltzer, 2010). This combination of information will be implemented because, as explained above, Autism Spectrum Disorder, High Functioning Autism, and Asperger's Syndrome, share the same social/emotional/facial recognition deficit. Another reason for this combination of information is the nature of Autism Spectrum Disorder; it is on a spectrum. Asperger's Syndrome is on the high-functioning end of this spectrum.

As mentioned above, the deficits that individuals with Asperger's Syndrome face are mostly related to an inability to read facial and emotional cues/expressions. The nature of this deficit has much to do with their attention and processing of the systematically structured, yet dynamically unpredictable world around them.

Facial and Emotional Recognition Ability

The Cambridge Face Memory Test (CFMT) is a very sound measure for determining one's ability to remember and identify facial expressions (Duchaine & Nakayama, 2006). When administered the CFMT, individuals with AS performed significantly worse than neurotypical controls (Hedley, Young, & Brewer, 2011). This finding was not influenced by IQ, negative affect, or autistic traits. Thus exemplifying the significance of these lower than average levels of facial/emotional recognition ability in AS. This being said, there were some participants with AS that performed at or above the average level for their age group. Here it is apparent that facial identification and memory abilities displayed by those with AS are on a continuum, just as ability in general is on a continuum for those on the autism spectrum.

Leung, Ordqvist, Falkmer, Parsons, & Falkmer, (2013) used eye tracking technology to observe the fixation durations on social stimuli for both HFA and AS children, as well as a control group of neurotypical children. All three groups had a mean age of 10. Leung et al. (2013) found that children with HFA/AS and ASD had longer fixation durations on static images of faces displaying basic emotions, compared to controls. This suggests that the HFA/AS and ASD groups were able to recognize emotions, but the task of recognizing was more demanding and time consuming compared to controls. Along with longer fixation durations on facial stimuli, those on the spectrum also have lower neural activity in the fusiform and frontal regions when viewing emotionally salient stimuli, compared to controls (Hall, Szechtman, & Nahmias, 2013). This demonstrates a neurological difference between ASD individuals and neurotypical individuals, when processing facial stimuli. (Hall et al. 2013) utilized a cross modal (visual and auditory) task that attempted to enhance the cortical response to facial stimuli in HFA participants. They inferred from their results that people with

HFA place less emphasis on facial information. This lack of emphasis was observable in the extraction, assembly, and evaluation of facial expression and emotional experience for those with HFA (Hall et al. 2013). In conjunction, these studies imply that individuals on the autism spectrum find facial stimuli to be both more demanding and less interesting compared to neurotypical individuals.

Deruelle, Rondan, Gepner, & Tardif (2004) investigated whether this deficit in facial processing was limited to just emotion recognition. In their first study, children diagnosed with either ASD or AS comprised autistic group. The autistic group as well as a control group viewed 25 black and white photos of adult faces. Both group's ability to match for gender, gaze direction, emotion, and identity was tested. The autistic group was deficient in matching gender, gaze direction, and emotion. Their facial identity matching ability was not impaired, though. This implies that other aspects of facial processing, not just emotion, are impaired for those on the autism spectrum.

Facial processing. Kikuchi, Senju, Tojo, Osanai, & Hasegawa (2009) examined whether children with ASD attend more rapidly to faces, or to objects, in comparison to matched neurotypical controls. In their first experiment, a sequence of photographs were presented to participants, starting with an original image and then a "changed" image. This sequence was looped until participants were able to identify a change. Each photograph featured one or two people, and a couple of objects. Their faces were referred to as the "head area". Areas of the photographs were also deemed to be of either central or marginal interest. The central areas of interest included at least one person and object, while the background was marked as an area of marginal interest. Results showed that children with ASD made more

errors and were slower to detect change in the head area, or one of the areas of interest, than the neurotypical group. These results imply that children with ASD pay less attention to faces than neurotypical children do (Kikuchi et al. 2009). Along with paying less attention to faces, children with AS tend to process faces in a piecemeal manner, rather than holistically.

One study investigated whether or not individuals with AS have difficulty switching from local to global processing, by using navon type hierarchical stimuli that included incongruencies (Katagiri, Kasai, Kamino, & Murohashi, 2012). Processing at a local level involves fragmented and segmented attention to detail. Processing at a global level is a more holistic and all-encompassing processing style, which usually takes context into consideration. The incongruences within this stimuli pertained both to local and to global processing. Thus, switching from local to global processing would entail inhibiting local processes, in order to enhance global processes. Results showed when switching from a local level to a global level, participants with AS had longer reaction times than neurotypical controls. These longer reaction times exemplify the difficulty they experience when switching from local to global processing. It also implies that the AS group had more difficulty inhibiting mechanisms that affect enhanced local processing. In addition, they had weaker global processing compared to neurotypical controls, which was countered by their enhanced local processing (Katagiri et al., 2012). These results are explained by theoretical interpretation in a review by a leading expert on autism, Simon Baron-Cohen. Neurotypical individuals possess the ability to switch from local to global level processing, whilst never losing sight of the "larger picture" or "gist" (Baron-Cohen, 2003). It is argued that people on the autism spectrum do not have a drive for this coherence, or consistency, between local and global information. Therefore, they pay close

attention to only the fragmented sets, and/or local information that is available (Baron-Cohen, 2003).

Inattention to faces. Prior research has demonstrated that ASD individuals do not pay as much attention to human faces, as compared to neurotypical individuals. These studies have ascertained this finding by observing the fixation durations and point/direction of gaze that AS individuals demonstrate. McPartland, Webb, Keehn, & Dawson (2010) completed a study in which the point of gaze during passive viewing of a variety of faces was recorded for ASD individuals, and neurotypical individuals. The faces viewed during this experiment included: upright human faces, three dimensional curvilinear forms, inverted human faces, two-dimensional geometric patterns, inverted human faces, and monkey faces. They found a difference between the neurotypical group and the ASD group, specifically in that the ASD group devoted more attention to the upper portion of the stimuli, rather than the lower portion. Importantly, this was found in the viewing of upright human faces. While this difference in location of gaze is minute, it still indicates a difference in how ASD individuals observe faces, and the visual attention they give to faces, compared to neurotypical individuals. This notion was further investigated in a study that observed gaze behavior of ASD participants as well as Williams Syndrome, which is a neurodevelopmental disorder, compared to neurotypical controls (Riby, & Hancock, 2008).

Riby & Hancock (2008) utilized eye-tracking technology to observe the attention given to faces by these three groups. The two types of facial stimuli used were scrambled pictures containing faces, and pictures of scenes with embedded faces. They hypothesized that neurotypical participants would detect and focus their attention to both types of facial stimuli,

and their results supported this hypothesis. In contrast, the participants with ASD exhibited less face gaze, as well as shorter fixation durations towards both types of facial stimuli. They went on to discuss that their results imply that faces do not capture the attention of ASD individuals. Importantly, they also mention that the use of precise eye-tracking technology was necessary to obtain subtle atypicalities of attention allocation in ASD individuals. Along with atypical gaze behavior towards faces, faces in a variety of stimuli do not seem to capture the attention of ASD individuals. In order to further understand the lack of attention paid to faces, other studies have observed the neural activation in ASD when viewing facial stimuli with enhanced emotional salience.

Hall, Szechtman, & Nahmias (2003) observed the neural activation patterns in ASD and AS, in an attempt to better understand their neural patterns of recognition and attention to faces. They included a prosodic voice along with the facial stimulus, in order to enhance the emotional saliency of the facial stimulus. They also included a control group of age-matched neurotypically developing adults. Regional cerebral blood flow (rCBF) was monitored during the viewing of two different tasks, which were repeated four times. The two tasks included: an emotion recognition task, and a baseline task of gender recognition. In the emotion recognition task, participants were told to match the emotional quality of the voice to the corresponding emotion presented in the face stimulus. In the gender recognition task, participants were told to match the prosodic voice to the gender of the facial stimulus. They observed that the ASD participants differed on their neural activation, when the emotional salience of the facial stimulus was enhanced by the prosodic voice they heard. The details of which brain regions this study found to be activated will not be reported here. Yet their findings implied that high

functioning autistic individuals "place less emphasis on the extraction of facial information and the assembly and evaluation of an integrated emotional experience than do subjects without autism" (Hall, Szechtman, & Nahmias, 2003, p. 4). Furthermore, differences in neural activation between ASD participants and neurotypical control participants indicate the processing style commonly seen in ASD. That is, ASD individuals were found to process faces in a more featural manner, rather than a holistic manner. This backs the "local processing" observed in Katagiri et al., (2012). These differences in neural activation were also proposed to indicate that ASD individuals utilized detailed categorical perceptual knowledge to dictate their judgement of facial stimuli.

Weak Central Coherence Theory

A theoretical explanation for this detail oriented, or "local" processing seen in children with autism is the Weak Central Coherence (WCC) theory. In a review on executive dysfunction, Hill (2004) defines a strong central coherence as the ability to understand experiences or instances within context. A strong central coherence is also said to come at the expense of detail. The reverse of this would characterize a Weak Central Coherence by enhanced attention to detail, and piecemeal processing. Rather than a deficit, the retainment of either a weak or strong central coherence is viewed as an information processing style (Hill, 2004) and/or a bias (Happé & Frith, 2006). It is proposed that people on the autism spectrum have a Weak Central Coherence, and therefore pose a focused attention to detail and vast factual knowledge (Hill, 2004). This also implies that those on the spectrum understand and interpret the world around them through a process that lacks contextual meaning. Happé & Frith (2006) view this lack of contextual meaning as a the residual effect of their robust

superior local processing ability. Here, it is noted that socialization in any regard is highly dependent on context. WCC can partially explain the deficiencies in ASD with understanding and comprehending many facets of socialization.

Stemming from the Weak Central Coherence theory, Deruelle et al., (2004) completed two experiments that looked into the abilities of autistic children with regards to their configural vs. local processing of faces. The first experiment tested their ability, compared to controls, to match faces on a variety facial tasks. The difference between these faces was the necessity for either local or configural (global) analysis. The second experiment utilized the same groups (ASD and control), but manipulated spatial frequencies of the stimuli. This manipulation allowed the researchers to observe the role of configural versus local processing, with regards to how people with ASD process faces. The manipulation was backed by the idea that low spatial frequency images require configural processing, and high spatial frequency images require local processing. Experiment 1 revealed that children with ASD had issues with matching for identity, gaze, and emotional expression. These are all said to require configural processing. Therefore, children with ASD do have a configural processing deficit compared to controls. This again implies that children with ASD utilize different facial processing strategies compared to controls. Experiment 2 revealed that children with ASD based their judgements on high spatial frequency cues, and that using these cues exemplifies their preferential mode of processing faces. They also performed better when utilizing high spatial frequencies, or local processing, compared to controls.

Hyper-Systemizing Theory

Both Baron-Cohen (2006) and Baron-Cohen, Ashwin, Ashwin, Tavassoli, & Charkrabarti (2009) pose that individuals with Autism systemize far more often, and to a higher degree, compared to neurotypical individuals. They rely on a highly predictable, straightforward, stable, and lawful systems. Due to the nature of hyper-systemizing, anything that defies the reliability of these systems also defies what they are most comfortable with, and what they know best. Therefore, the "hyper-systemizing" theory is backed by a resistance to change, which is characteristic of autism and AS (American Psychiatric Association, 2013; Baron-Cohen et al., 2009). Strong systemizing serves as an explanation for the non-social features people on the autism spectrum display. These features include narrow interests, repetitive behavior, and resistance to change (American Psychiatric Association, 2013). According to this theory, when working with those on the spectrum one must keep everything constant and consistent to best address the way in which they process the world around them (Baron-Cohen et al., 2009). Doing so aids the child in understanding what causes what. Additionally, the child can verify patterns and sequences, observed through repetition (Baron-Cohen et al., 2009).

The nature of human being's interactions, reactions, and decisions is highly variable and rarely predictable. For neurotypical individuals, this is just another part of everyday life that is mostly handled subconsciously, with ease. Social situations, to most, aren't internalized or thought of as stressful and uncomfortable. Baron-Cohen (2006) suggests that children with AS attempt to impose control, synchrony, and predictability in their lives. They do so because to them, social interaction is viewed as unpredictable, and therefore extremely confusing. This process of systemization can be seen as children with AS/ASD being captivated by a specific

aspect of reality (Baron-Cohen, 2013). From here they attempt to uncover the laws of the underlying system, or network, that this aspect operates under. Under these pretences, certain types of information lend themselves to hyper systemizing more than others. Proficient and enhanced systemizing is said to also come with a detachment from context (Baron-Cohen, 2013). "Hyper-systemizing" theory, in tandem with the WCC theory, can theoretically illustrate and explain the nature of obsessions held by children with AS/ASD, as well as their problems with the processing of facial/emotional/social situations. These two theories also lend explanation to the Theory of Mind deficit that is highly documented in AS individuals.

Theory Of Mind (ToM)

In a book written by Simon Baron-Cohen entitled Mindblindness: An essay on Autism and Theory of Mind (Baron-Cohen, 1997), he defines "Theory of Mind" (ToM). ToM refers to the ability to infer a wide variety of mental states, from behavior. This implies that one is able to understand behavior with regards to "volitional mental states (desire and goal), and eye direction in terms of perceptual mental states (seeing)" (Baron-Cohen, 1997, p. 51). ToM also incorporates the understanding that different individuals can experience different mental states, in relation to the same object or instance. Epistemic mental states are also necessary for representing ToM abilities. These are defined as instances such as pretending, believing, guessing, dreaming, and thinking. One must link the volitional, perceptual, and epistemic states in order to fully understand how behavior and mental state interact, and are represented. ToM allows one to observe and internalize these epistemic mental states, which eventually lends itself to subconsciously developing applicable theory regarding them. ToM is referred to in many bodies of literature that investigate ASD. It is said that those on the spectrum do not

posses ToM abilities, which manifests in a lack of social understanding and ability. This absence of understanding and processing of other's mental states is problematic, but it is further proposed that ASD individuals aren't aware that mental states exist and can even be shared. Throughout the lifespan of an ASD individual, this unawareness and lack of understanding of other's mental states can negatively manifest. Manifestations of a ToM deficit include trouble forming social relationships, romantic relationships, occupational relationships, and residual depression and anxiety.

Ribeiro & Fearon (2010) observed the relationship between the ability to recognize facial and emotional expressions, and ToM abilities. This study did not use ASD participants. They hypothesized that in order to possess ToM, one must pay rigorous attention to facial expressions, in order to code for the emotions displayed by another individual. Once emotions and facial expressions are understood and recognized, only then can one go on to implore ToM. They go on to mention that subpar ToM skills are often associated with problems in areas of social and interpersonal interaction, such as emotion and facial recognition. The ability to attribute mental states to others entails an awareness to these minimal non-verbal cues. An interesting finding from their study revealed that participants with poor ToM skills tended to look more towards faces with a negative-affect. It was hypothesized that this was an adaptive mechanism, which people with poor ToM skills demonstrate in an effort to avoid danger in a social environment. It is important to note that this finding demonstrates the necessity of facial/emotional recognition in the development of ToM skills.

Tager-Flusberg (1992) observed 6 ASD children, and 6 matched control participants who had been diagnosed with Down Syndrome. The participant's language was assessed and

coded for utterances that pertained to perception, emotion, desire, and cognition. These utterances were further assessed and coded for their reference to mental states, and calls for joint attention (sharing attention with another). The ASD group differed significantly from the Down Syndrome control group on their signaling for joint attention, and reference to cognitive mental states (Li, Kelley, Evans, & Lee, 2010). Thus indicating a deficit in their understanding and processing of other's mental states and calls for joint attention, which are both essential to ToM.

As prior literature has well established, individuals on the autism spectrum demonstrate a ToM deficit. As this proposed study centers around facial/emotional cues, it's important to highlight the connection between these cues and ToM. This connection was detailed in the re-cap of Ribeiro & Fearon (2010)'s study above. It is believed that a network of connections between facial/emotional cues, ToM deficits, deception, and false belief is present in ASD functioning and lifespan. The next section entitled "Theory of Mind, Deception, and False Belief" is included in order to present the cascading and subsequent effects of facial/emotional recognition deficits in ASD, throughout lifespan and life experience.

Theory of mind, deception, and false belief. The abilities that ToM acquisition offer are vital to human interaction, on many different levels. Let alone the ability to infer other's mental states, and understanding that different people will experience different mental states in relation to the same object or instance, ToM allows for much more. In a chapter written by Uta Frith & Chris Frith (2005) entitled "Theory Of Mind", it's mentioned that ToM allows one to manipulate other's beliefs, while in turn, manipulating their behavior (Frith, & Frith, 2005). For example, in the instance of regarding another as a friend or enemy, those who poses ToM

are able to manipulate the behaviors of others based on what one can infer from the other's mental state and perception. This chapter exemplifies an instance where there is a rock with a scorpion behind it. If another person who is considered a friend is about to pick up this rock, unaware of what lays behind it, the observer and friend of this person would stop them from picking it up. This would simply be because they understand what the other person's perception of the rock is, and therefore are able to instruct them to go about their actions carefully. The reverse would be the case if the observer of this instance thought of the other as an enemy. In this situation, the observer would allow them to pick up said rock, knowing that they are unaware of the poisonous animal that sits beneath it. Here, the observer is deceiving the other by not notifying them that they are in danger. They label this specific facet of ToM as "tactical deception".

An interesting study aimed to test the ability and understanding of deception that ASD individuals possess. Baron-Cohen (1992) sought to replicate the findings of a prior study that found autistic individuals to have have an impaired understanding and internalization of deception (Oswald & Ollendick, 1989). Baron-Cohen (1992) utilized a well known penny hiding game. Simply put, the participant places a penny into either one of their two hands. The "guesser" is then supposed to guess which hand the penny is in. Here, it is apparent that hiding the penny from the guesser is an act of deception. In this study, they parsed out two specific facets of the deception within the penny hiding game: *object occlusion*, and *information occlusion*. They found that autistic individuals were entirely capable of enjoying the game as object occlusion. In other words, they understood the game as a means of hiding an object such that it is out of sight. Yet unlike controls and those with a mental handicap that placed them at

a lower or equivalent mental age as the autistic participants, those with ASD were unable to perceive the game as means of keeping things out of mind. This is referred to as "information occlusion". These results were observable in the behavior of the ASD subjects versus the other subjects. The ASD group tended to reveal where the penny was hidden, to the "guesser". They also failed to hide the object out of view, which allowed the guesser to infer the location of the object. This insinuates that they were oblivious to the "guesser's" beliefs, and therefore were unable to employ Theory of Mind. Finally, this study connected this lack of understanding of information occlusion to the documented inability of ASD individuals to understand that "seeing leads to knowing" (Baron-Cohen, 1992). An inability to understand this notion deeply affects their ability to deceive others.

Deception is also associated with honesty and lying. To deceive someone can also be viewed as lying to them. To believe the deception is to trust the deceiver. Due to the nature of deception, research has attempted to uncover the specifics of ToM abilities in autism by utilizing honesty, lying, trust, and mistrust in their paradigms. Yi et al., (2014) investigated ASD individual's capacity to trust, and their ability to retaliate against a deceptive adult by using deception themselves. They observed a group of ASD children, as well as group of matched neurotypical control children. Adult informants repeatedly misinformed the children as to the whereabouts of a hidden prize. They attempted to tackle three facets within this experiment, the first two of which are discussed here. The first was to observe if ASD children had an indiscriminate trust bias towards an adult who was introduced as "tricky", and "not wanting you (them) to find the prize". In order to test the trust of the participants, participants who looked in the area where they were instructed to by the deceptive adult informant were

labeled as trusting, whereas the participants that didn't do so were labeled as not trusting. Results showed that the ASD group trusted the adults significantly more than controls. Another facet they looked at was whether or not the participants would retaliate, via deceiving the adult regarding the whereabouts of the prize. Here, children were instructed to hide the prize from the adult. They were then asked, by the deceptive adult, where they had hid the prize. If the participants lied about the whereabouts of the prize, then they were marked as having retaliatory deception abilities. The opposite was true if they did not lie about the whereabouts of the prize to the deceptive adult. Children with ASD lied and deceived significantly less than controls, implying they do not possess retaliatory deception abilities. Here it is clear that children with ASD are unable to discriminate between deception and truth. They were unable to use ToM to place themselves in the deceptive adult's mindset, and therefore unable to infer that the adult would deceive them. This idea is closely linked to false belief ability.

As deception has much to do with belief between one person and another, research has investigated much to do with the connections between autism and false belief, as well as deception. False belief is the understanding that another's beliefs and mental states might contrast with reality, or contrast with one's own beliefs and mental states. It also has been indicated as being one of the key elements of, and abilities within, ToM. False belief tasks demonstrate one's ability to differentiate between their own true belief and awareness, and their awareness of differentiating belief and awareness in others. First-order false belief tasks test one's ability to differentiate between other's false beliefs in relation to real life events. For example, this would include the understanding that another person believes they lost their car keys, when in reality the observer knows where the keys are. Second-order false belief tasks

assess one's ability to understand and infer other's false beliefs which are based on the thoughts of another. For example, this would include the understanding that one person believes a marble is inside of a box, based on another person's belief that a marble is in that box. Here, the ability is to infer other's mental states/beliefs that originate from a third party's mental states/beliefs (Bauminger-Zviely, 2013).

Furthermore, another study by Perner, Frith, Leslie, & Leekam (1989) observed 26 autistic children that were tested on tasks that were designed for neurotypical children of the same mental age. They used a group of language-delayed children as a control for a subgroup of the original 26 ASD participants. One of the tasks included a false belief. Here, children were shown a Smarties box. Thus, the child should have believed that there are sweets inside of the box. But, the researcher revealed that the box contained something else. In the instance where they observed another person peering into the same box expecting the same sweets, only 4 out of the 26 ASD participants were able to infer that this child would be surprised by the content of the box as well. Following the false belief task, they implemented a communication test. This test included two 'ignorance' sublevels. In the 'partial ignorance' sublevel, both experimenters as well as the ASD participant were shown a toy bee and told that it could "fly". After demonstrating what the bee could do, one of the researchers left the room claiming they had misplaced their handkerchief. The remaining researcher then demonstrated how the toy bee could also "nod it's head". In the "complete ignorance" sublevel, the experimenter who claimed to have lost their handkerchief left before the other experimenter presented the toy bee, and explained the two actions that the toy bee could do. Upon the other experimenter's return, they asked the subject "what can the bee do?". The results indicated that the only time that the

ASD participants told the returning experimenter what the bee could do, was in the 'partial ignorance' sublevel. Though, ASD participants only mentioned this one third of the time. They did not inform the returning experimenter of what the bee can do in the 'total ignorance' sublevel. This indicates that they are somewhat able to adjust their communication based on false belief, but not nearly to the same degree that neurotypical children of their same verbal age can. It is noted that only a small minority of ASD children, with a verbal age of up to 13 years, understand false belief. Yet this understanding is well developed by age 4, in neurotypical children (Perner et al., 1989).

In conclusion, these results further exemplify the ToM deficit in ASD children. An inability to read other's mental states, share joint attention, deceive others, and distrust deceptive individuals can have a great negative impact on the daily and social functioning for those on the autism spectrum. These deficits are also said to influence their ability to empathize with others, which in its own can manifest in a vast amount of problems with socialization.

Mindblindness and Empathizing

Abilities involved with ToM, such as the ability to deceive and understand other's mental states and beliefs, are also referred to as "mind-reading" or "mentalizing" in literature that examines ToM in ASD. Simon Baron-Cohen originally coined these terms. He proposes that those on the autism spectrum might be largely unaware of the existence of a plethora of mental states, which neurotypical individuals take for granted (Baron-Cohen, 1997). This can unfortunately manifest in a lack of empathy towards others.

Evolutionarily, he also proposes that mankind has developed the brain mechanisms necessary for complex social situations and living with and among groups of other people. In

other words, adaptive strategical social functioning and the understanding of other's mental states has developed due to the group living that has occurred throughout evolution. An example could be observed in the nature of predator and prey; predators who were able to understand their pray's mental state and/or beliefs would have profited more than predators who do not have this ability. This idea is also easily connected to natural selection, as the most fit to survive were those who were able to mentalize other's mental states and possible actions. Alongside the evolutionary backing behind ToM abilities, comes the developmental nature that a lack of such abilities predicts.

In detailing his theory of "mentalizing" or "mindblindness", Simon Baron-Cohen also procured a set of milestones that due to "mindblindness", would be absent in children on the autism spectrum. He listed these milestones as: failure to point at or share objects of interests , failure to follow another person's gaze (both of which indicate joint attention ability), and failure to understand make-believe play (Frith, 2001). Since these initial predictions, research has found these early signs of mentalizing disability to be predictive indicators in autism screening tests. The theory of "mindblindness" or an inability to "mentalize" certain aspects of the socialization and facial recognition is exemplified in ASD individuals. In turn, the ability to "metalize" other's mental states or beliefs that is well developed in neurotypical individuals, is lacking in those on the autism spectrum. Hence the use of the word "mindblindness" in the describing the lack of ToM autistic individuals display (Frith, 2001).

This ability to "mentalize" what other's are feeling/seeing/thinking, is inherently connected to one's ability and capacity to empathize with others. Frith & Frith (2005) wrote on ToM in autism, making this connection. The inability to conceive of, understand, and process

other's mental states leads to many social inabilities, the lack of empathy for another person being of the most profound. Ellis & Bjorklund (2004) review Simon Baron-Cohen's book *Origins of the Social Mind: Evolutionary Psychology and Child Development*, where he delves into the symbiotic yet destructive relationship of systemizing and empathizing within autism. As mentioned before, those with ASD are said to be hyper-systemizers. Again, systemizing can be seen as an inductive process. One observes instances around them, gathering data from consecutive and/or repeating events. Afterwards, predictable results can be found from patterns, correlations, and variations. Upon confirming that these these predictable results are reliable, one goes on to form a rule about how this system works. Systemizing does not aid in predicting moment-to-moment outcomes, which are highly present in social interaction. On the other hand, empathizing does not rely on data. It is not of a system, nor does it always entail that the final assumption is correct or incorrect. It is therefore unpredictable, unstable, ever-changing, and highly contextually dependent. It is vital to how humans fare in a social world. Therefore, ASD individual's ability to hyper-systemize also manifests in an inability to empathize. Finally, this hyper-systemization and lack of empathy, in combination ToM deficits, manifest in the series of social functioning deficits that those with ASD display.

Obsessions in Asperger's Syndrome

Children with AS tend to have special interests, or obsessions, that are likely linked to the repetitive and patterned behavior, which are detailed in the DSM-V (American Psychiatric Association, 2013). Interestingly, lower order behaviors are tied to the lower cognitive functioning end of the autism spectrum (Boyd, Conroy, Mancil, Nakao, & Alter, 2006). These lower order behaviors are often categorized as simple and stereotyped repetitive behaviors.

Contrasting the lower cognitive functioning end of the autism spectrum is the higher cognitive functioning end of the spectrum, which includes AS. Here, higher order and more complex routine repetitive behaviors are apparent, such as obsessions (Boyd et al., 2006). Obsessions in AS are also referred to as Circumscribed Interests (CI's) in some bodies of literature.

CI's, or obsessions, are present in over 90% of children and adults with AS (Prior, 2005) . Yet literature seems to have the least clinical knowledge of this area of AS. Prior (2005) also notes that those with AS devote a disproportionate amount of time to, and assemble a vast amount of knowledge about, their objects of interest (or CI's). These CI's are also engaged with and tended to by AS individuals far more than other interests and activities. This occurs at an intensity that disrupts certain areas of functioning; the most important area being social interaction. It's even mentioned that the amount of infatuation and attachment that AS individuals display towards their CI's is sometimes more than they display towards their family members. Furthermore, teachers with AS students notice that their "attention to detail when engaged in their circumscribed interest is impressive, the same degree of motivation, attention, and ability is conspicuously absent when other classroom activities are the focus, especially the activities that would be of interest to their peers" (Prior, 2005, p. 129) These teachers also mentioned that their devout attention to their CI's interferes with the amount of attention they devote to group activities, as well as their social involvement.

A similar study sought to observe the nature of arousal and valence devoted to CI's, by ASD individuals. Sasson, Dichter, & Bodfish (2012) asked the question of whether or not neurotypical adults and ASD adults differed on subjective ratings of three different sets of image stimuli. The first set included social image stimuli, the second set contained non-social

image stimuli that was related to common CI's in ASD, and the third set included non-social image stimuli that was not related to common CI's in ASD. They attempted to parse out two dimensions. The first being the *arousal* dimension, which was defined as the extent to which an emotion correlates with an increased sense of energy, such as going from calm to excited. The second being the *valence* dimension, which is defined as the extent to which an emotion incites a positive or negative mood that would ultimately affect withdrawal, approach, and motivation. Results revealed the neurotypical controls and the ASD subjects did not differ on the arousal dimension, on all three image stimulus sets. Instead, there were significant differences within the valence dimension. ASD subjects rated the non-social CI-related image stimuli to be more positively experienced than the social image stimuli, compared to the neurotypical controls. Furthermore, they rated the social image stimuli as less positively experienced, compared to the neurotypical controls. Here it was noted that the ASD subject's higher ratings of pleasure on non-social CI-related image stimuli also indicates the increased salience of said stimuli, to ASD individuals. It is proposed that ASD individuals must be biased away from social stimuli, and therefore biased away from social interaction. As this bias seems to favor non-social aspects over social aspects, it is proposed to ultimately manifest in reduced social motivation, and increased interest and interaction with non-social CI-related aspects. This study further demonstrates the lack of valence that socially related instances and experiences have for ASD individuals. Their CI's, or obsessions, seem to take precedence over many areas of functioning, and especially over anything to do with socialization.

Another study attempted to divulge the visual attention paid by children with ASD to social stimuli. Sasson, Turner-Brown, Holtzclaw, Lam, & Bodfish (2008) used a passive

viewing task of images that featured social content, as well as non-social content. The social stimuli featured images of people with very visible and distinct faces. Interestingly, the non-social stimuli included items and objects, some of which related to CI's in autism (eg. trains). Eye-tracking technology was used to observe their gaze behavior. They noted that the autistic group displayed more circumscribed, detail-oriented, and pervasive gaze behavior when viewing the non-social stimuli. This style of visual attention was in concordance with the well-known processing styles and behavioral characteristics within autism (American Psychiatric Association, 2013; Katagiri et al., 2012). Importantly, this was only displayed when viewing the non-social stimuli that happened to feature objects that related to common CI's in autism. Again, they did not demonstrate these visual attention patterns when viewing the social stimuli. They concluded that non-social and CI related images were far more salient to the ASD participants than images that featured faces and social context. This finding further demonstrates the pertinence of CI's (or obsessions) to those on the autism spectrum. This also said to contribute to their lack of interest in, and understanding of, socialization as a whole.

In an attempt to better understand the nature of these CI's, or obsessions, prior research has compared them to the obsessions experienced by people with Obsessive Compulsive Order (OCD) (Ruta, Mungo, Genitori D'Arrigo, Vitello, & Mazzone, 2009). Ruta el at., (2009) investigated the frequency and characteristics of obsessive-compulsive behaviors in children with AS, and compared these findings to an OCD group and healthy control group (Ruta et al., 2009). While the OCD group reported a higher severity and frequency of contamination and aggressive obsessions, the AS group reported higher frequencies of hoarding, repeating, and ordering obsessions. This finding connects back to the previously described theory of

"hyper-systemizing" (Baron-Cohen et al., 2009; Ellis & Bjorklund, 2005, p. 483-485; Baron-Cohen, 2003). More interestingly, the AS group completely lacked insight as to the intrusive and distressing nature of their symptoms, compared to the OCD and control groups. This finding is theoretically explained as a difficulty in attributing rituals and obsessions to deficient processing and a lack of mental state awareness, in AS. This difficulty, along with devout obsessional qualities of a repetitive nature, partially demonstrates why AS individuals subconsciously prioritize their objects of obsession over anything to do with socialization.

Although decently unexplored, the content of the obsessions experienced by those with AS was parsed out in a very telling study. Baron-Cohen & Wheelwright (1999) stated that a "content-free analysis of obsessions is inadequate". They surveyed the parents of children with ASD conditions by means of the Cambridge University Obsessions Questionnaire, in order to assess what category the content of their child's obsessions fell under. These findings were compared to controls, which comprised of a Tourette's Syndrome group, and Attention Deficit with Hyperactivity Disorder group. They define two major umbrella terms that the obsessions observed in their study could be categorized under. These terms are derived from core cognitive domains that are proposed to be necessary for the basic challenges of predicting an object in motion in the physical world, and the intricacies of a social environment. The first is "Folk Psychology". This is defined as having both basic knowledge and interest in how the social world, and people, work. Frith & Frith (2005) also refer to "Folk Psychology" as "explanations for everyday behavior, in terms of mental states." The second is "Folk Physics". This is defined as having both basic knowledge and interest in how the physical world works. They claim that if obsessions in autistic children reflect what they are interested in and areas

they might excel in, then these obsessions should cluster in specific core cognitive domains. They specifically predicted that obsessions for children with AS would cluster under, and be significantly reduced to, the "Folk Physics" domain. Results from Baron-Cohen & Wheelwright (1999) showed that in agreement with clinical reports (as cited by: Bettleheim, 1968), children with AS show significantly more obsessional interests that fall under the core cognitive domain of "Folk Physics". Furthermore, it's mentioned that the parents of children with AS show minor deficits on an adult folk psychology task (as cited by: Baron-Cohen & Hammer, 1977). They also are overrepresented in occupations that require, or offer an advantage for, superior "Folk Physics" ability. A study found even found that the grandfathers of children with ASD or AS "were more than twice as likely to work in the field of engineering, compared to controls" (Baron-Cohen & Wheelwright, 1999). The field of engineering requires many abilities that fall under the "Folk Physics" domain. These results are easily tied back to the "Hyper-Systemizing" theory, as "Folk Physics" relies on predictable systems such as the physical world, that is devoid of human error and chance. Hyper-systemizing and Weak Central Coherence theory can partially explain the reasoning behind the clustering of obsessions under the "folk physics" category.

Baron-Cohen (1997) goes into further detail by referencing both experimental and clinical contexts that allowed for demonstration of superior "Folk Physics" interests and abilities in children on the autism spectrum. One experiment referenced involved asking children with ASD to take a picture of a scene, with a polaroid camera pointed at said scene. While the photo developed, objects from the scene were moved around. They were then asked where in the photo the object would be located. The children were able to answer correctly,

which is highly contrasting of their scores on false belief tasks. This infers that children with ASD have deficient understanding of mental representations, but adequate and possibly excelled understand of the physical world. Baron-Cohen (1997) also refers to children as "little professors" of their favorite subject. While they are well versed and completely engaged in said subject, they fail to realize when the listener becomes bored or uninterested in the discussion of their favorite subject. An instance like this could be exemplary of their issues with reading social/emotional facial cues, as well. Prior research has quantified this mastery of their special interests as a means of "providing a map of the human world which is otherwise such a closed book" (Klin, Volkmar, & Sparrow, 2000, p. 387). All of these theories and findings come together to illustrate the best ways to design a facial/emotion recognition intervention that would best suit a child with AS.

Individualized Treatment and Intervention

In a book entitled *Asperger's Syndrome*, there is a chapter entitled "Treatment and Intervention Guidelines for Individuals with Asperger Syndrome" (Klin, Volkmar, & Sparrow, 2000, p.125-141). Here, the necessity for individualized intervention with Asperger's children is made clear. They suggest that programs and interventions should address the specific needs and deficits of an individual AS child. This also should be done in a way that capitalizes their assets and abilities. In order to address the specifics of an individual child, the interventionist must fully understand the profile of skills and deficits of the child. Most importantly, they should focus on skills and deficits that are central to learning, communicating with others, and understanding others. Klin, Volkmar, & Sparrow (2000) also suggest that most resources available to children with AS are resources primarily created for those who fall on all ends and

areas of the autism spectrum. Schools tend to place children with AS and ASD together, which completely negates the necessity for individualized treatment. Often times these programs will mainly target problem behavior seen in children with AS, while ignoring where these behaviors originate from. Therefore, children with AS are unable to profit from these resources, as their abilities and deficits are quite different from those on other areas and ends of the autism spectrum.

Prior literature has only scratched the surface of individualized and specialized interventions for AS children. Studies completed in this field have designed interventions that are modeled to be more perceptible and attention catching to AS children. These studies have not yet tested the efficacy of individualized intervention that is tailored to the student or participant's individual obsession.

Aim of Study and Hypothesis

This proposed study intends to create and test an individualized facial/emotional recognition intervention geared towards the processing style of AS children. Unlike Baron-Cohen et al., (2009), this intervention is tailored to the AS participant's specific obsession. This design is implemented in order to catch the attention and interest of the AS participant. Therefore, an intervention intends to improve the facial/emotional recognition deficit in AS, and that is tailored to the participant's specific obsession, is hypothesized to ultimately improve this deficit by catching their attention and appeasing their cognitive processing style. This study intends to observe the amount of attention participant's pay to the intervention via their fixation durations. Participants who view an intervention that features content that does not pertain to their specific obsession are hypothesized to not improve on

their facial/emotional recognition ability, while participants who view an intervention that is tailored to their specific obsession are hypothesized to improve on this ability. Furthermore, participants who view an intervention that features content that does not pertain to the content of their specific obsession will not present long fixation durations, while participants who view an intervention that is tailored to their specific obsession will.

Methods

Participants

Recruitment. Although Golan et al., (2009) posted ads for their study in the National Autistic Society magazine, this study will advertise and recruit at a nearby center for autism. The center is called the Anderson Center for Autism, and is in upstate New York. This center provides an array of services for children on the autism spectrum including: behavioral support strategies, specialized education via the help of a variety of specialists, social skill development, diagnostic services, consultation, and much more. Flyers will be available at the front desk, and posters will be visible on the bulletin boards throughout the facility. The flyers and posters will advertise an opportunity to participate in a psychological study that explores emotion recognition and obsessions in children with AS, which is how Golan et al., (2009) advertized their study. Although Golan et al., (2009) recruited participants from all areas of the autism spectrum, this study will only recruit and advertise for participants with Asperger's Syndrome. The advertisements will also clearly dictate that this study is only recruiting children who are obsessed with either clocks, or trains. Potential participants and their parents are urged to contact the research facility.

Participant details. A large initial sample of male participants will be recruited from the Anderson Center for Autism. Participants will be only male, due to higher rates of Autism in males (Croen, Grether, & Selvin, 2002). After determining which participants meet the criteria for this study, all participants that do not meet the criteria will not be asked to return. A total of 80 male participants will be remain in the study. Furthermore, 40 of these remaining participants will be obsessed with trains, and 40 participants will be obsessed with clocks. Golan et al., (2009) used 20 participants in their ASD experimental group, and 18 participants in their neurotypical control group. This study will use twice as many participants as Golan et al., (2009), which is proposed to increase the effect size. Participants included in the study are not expected to significantly vary on their baseline measure scoring. They will have a mean age of eight years old, with ages ranging from six to eleven years old. While not drastically numerically different, this age range not exactly the same as that which was used by Golan et al., (2009), which included participants between the ages of four to seven. This range was chosen in concordance with suitable age ranges for the baseline measures. It was also chosen in order to test the abilities and characteristics of children slightly older than those used in Golan et al., (2009), with hopes of expanding on their findings.

Design

This proposed longitudinal study will implement a repeated measures mixed design. There are two original groups: AS1 (obsessed with trains) and AS2 (obsessed with clocks). After the two original groups are determined, they are further randomly divided into a total of 4 subgroups (AS1A, AS1B, AS2A, AS2B) in order to complete group assignment. There are also two conditions: OBS (Obsession Specific) and N-OBS (Non-Obsession Specific). Each

subgroup is randomly assigned to one of the two conditions, such that each subgroup from the two original groups completes both of the two conditions. Refer to Table 1 in Appendix A for the exact conditions to which these subgroups are assigned. To test facial/emotional recognition ability, the Cambridge Mindreading Face-Voice Battery Test for Children (CAM-C) will be utilized. This test is taken pre and post the intervention viewing period. The first independent variable is the Obsession Match of the intervention, with two sub-levels of Obsession specific, and Non-Obsession Specific. The second independent variable is the Video Type, with two sublevels of Train and Clock. The dependent variable is Time, with two sublevels of pre-intervention, and post-intervention. Here, the dependent variable of Time reflects the pre and post intervention scores on the CAM-C, for each participant.

Apparatus and Materials

The autism spectrum quotient (AQ). Baron-Cohen, Wheelwright, Skinner, Martin, & Clubly (2017) report on a newly developed instrument known as the Autism Spectrum Quotient (ASQ). The available scores for the ASQ range from zero to 50. The ASQ was designed to examine whether or not symptoms of ASD are present in adults of average intelligence. A higher score on the ASQ implies a higher amount of autistic traits present in the participant. This study assessed four different groups of subjects including adults with AS, a group of neurotypical controls, a group of Cambridge University students, and lastly a group of adults who had won the UK Mathematics Olympiad. Results revealed that the adults with AS scored significantly higher (35.8) than the group of controls (16.4), on the ASQ. Furthermore, %80 of the AS group got a score that was above 32, unlike the %2 of neurotypical controls who scored above a 32. Interestingly, the group of UK Mathematical Olympiads winners, as well as the students from Cambridge University who majored in either science or mathematics, had significantly high scores. This result connects back to the idea that those on the

autism spectrum are proficient in both math and science, due to the heavy systemization involved with both practices (Baron-Cohen et al., 2009). This study also demonstrates that the ASQ had both retest and inter-rater reliability, as well as the ability to quantify where people fall within the autism spectrum. But how does the ASQ fare in the testing of Autistic traits in children?

Autism spectrum quotient - children's version (AQ-Child). Unlike the original ASQ which involves self-report, the Autism Spectrum Quotient: Children's Version (AQ-Child) is a parent-report quotient. Certain questions from the original ASQ that weren't considered to be age appropriate, were altered (Auyeung, Baron-Cohen, Wheelwright, & Allison, 2007). The quotient is designed to assess five areas of functioning that are often associated with ASD. These areas include: *social skills, attention switching, attention to detail, communication,* and *imagination*. Each of these areas of function are represented by ten items. Again, a higher score implies that more autistic traits are present in the participant. The AQ-Child is meant to asses ages from the range of four years of age, to 11 years of age. Thus, the age range of the AQ-Child covers the age range of participants in this proposed study. This test also differs from the original ASQ in range of possible scores, which is 0-150. The response scale includes a 4-point Likert scale, where parents rate the extent to which they agree or disagree with the questions that are being asked about their child. These scores are found within the 50 items of the questionnaire. Auyeung et al., (2007) implemented this quotient with a group of ASD children, spanning from high functioning to low functioning, as well as a control group of neurotypical children. They adopted a cutoff score of 76, which indicated high sensitivity and specificity. Importantly, scores at or above the cutoff score of 76 were found in 95% of the AS/HFA as well as in the autism group. This pales in comparison to the mere %4 of

neurotypical control participants who scored above the cutoff score. Additionally, comparisons between the AS/HFA and the autism group revealed no significant difference, in terms of the total score on the AQ-Child. Their results also revealed the high test-retest reliability of the AQ-Child. Finally, they suggest that this tool should not be used as diagnostic criteria, but rather to inform research on the nature, development, and presence of ASD. The AQ-Child will be implemented as a baseline measure in this proposed study in order to create homogeneity between and among subjects, as well as to determine the presence and nature of their autistic traits. The AQ-Child will be filled out by the parents of the child participants. The expected mean for participants on the AQ-Child in this study will be 115, due to prior findings indicating a mean score of 115 seen in AS individuals (Auyeung et al., 2007). Refer to Appendix B for the AQ-Child sheet as well as it's scoring key.

The childhood asperger's syndrome test (CAST). The Childhood Asperger Syndrome Test (CAST) contains 37 items that are meant to asses the presence of Asperger's Syndrome symptomology and characteristics in young children. It designed for the parent of a child participant to complete, as a known facet of ASD related conditions is that they are unaware of the nature of their disorder (Ruta el at., 2009). Therefore, the parent is best suitable to report on it. Each item features a question about the child's behavior and functioning, next to which parents are asked to mark either "yes" or "no". Two studies utilized participants who fell within all ends of the autism spectrum, in order to ascertain some preliminary findings. Williams et al., (2006) investigated the test's accuracy, and found both the sensitivity and specificity of the test to be above 90 percent. Furthermore, Williams, Allison, Scott, Stott, & Bolton (2006) investigated the test-retest reliability of the CAST, and found it to be sound in

this regard as well. While these studies backed the efficacy of the CAST, it was important to uncover whether or not it actually screened for AS, excluding all other areas and ends of the autism spectrum. Allison et al., (2007) found sound test-retest reliability for the CAST, in high scoring samples. This further backed the test's ability as a screening tool for epidemiological research. There is a maximum score of 31, and a cutoff score of 15. Scott, Baron-Cohen, Bolton, & Brayne (2002) found that those with AS scored an average of 21.08, which will be the expected mean score for participants in this study. The CAST will be filled out by the parents of the child participants. See Appendix C for the CAST sheet.

The wechsler intelligence scale for children (WISC-V). While this study tests emotional and facial recognition abilities of children with AS, it is important that each participant has a similar IQ profile. The fifth edition of the Wechsler Intelligence Scale for Children (WISC-V) will be implemented in order to do so (Wechsler, 1949). This scale is meant for ages six to 16, which covers age range of children that will be used in this proposed study. The WISC-V provides scores in five different areas of mental intelligence function: Verbal Comprehension (VCI), Visual Space Index (VSI), Fluid Reasoning Index (FRI), Working Memory Index (WMI), and Processing Speed Index (PSI). Each of these five indexes of functioning also include their own subsets. These scores then combine to produce a composite score, which is also referred to as the full scale IQ (FISQ) ("Wechsler Intelligence Scale For Children - Fourth Edition - Descriptive and Graphical Report", n.d.). In addition, five ancillary composite scores can be obtained via various combinations of the subsets listed above. Importantly, the WISC-V will be utilized only as a means for assessing mental function variability between participants, and not as a means of diagnosis. Children with AS have an

mean FISQ score of 98.3 on the WISC-IV (Nader, Jelenic, & Soulières, 2015). Although this is the mean score for a previous version of the Wechsler Intelligence Scale for Children, it will still be used as a guide for cutoff IQ scores in this study, as they do pertain to children with Autism. Therefore, this study will impose that participants must have a WISC-V FISQ score of at least 96. The expected mean for participants on the WISC-V is 98.3. The child participants of this study fill out the WISC-V, not the parents. Due to budgeting restrictions for this proposed study, the WISC-V was not obtainable and therefore will not appear in the appendix.

Parental questionnaire. This study will borrow from three prior studies that also investigated the nature and intensity of obsessions in AS and Obsessive Compulsive Disorder (OCD). These studies also delved into the extent to which these obsessions interfere with the everyday functioning of the individual. Reference to these studies, scales, questionnaires, and exact items will be done in order to design a parental obsession questionnaire that is all-encompassing, as well as fitting for the proposed study at hand. The order in which each study/measure to be borrowed from, described below, is not the exact order in which they will appear on the parental questionnaire.

Due to the nature of AS, children are often are unaware of the extent to which, and areas affected by, their obsessions and CI's. A study by Baker, Koegel, & Koegel (1998) investigated whether obsessive behaviors and topics seen in ASD children could serve as a functional theme of a social game. In order to asses what the exact obsessions of their AS participants were, they interviewed the children's teachers, teacher's aid, and parents. They also collected informal child observations. Importantly, the obsession topic had to have been considered abnormally pervasive by all observers and interviewees. The idea of interviewing

parents in order to gather this information will be borrowed from (Baker, Koegel, & Koegel, 1998). Instead of interviewing the full plethora of people that Baker, Koegel, & Koegel (1998) did, this study will only interview the parents of the AS children, utilizing them as the primary informant. The child will be present for the majority of the duration of the parental questionnaire, and will be encouraged to contribute if they feel the need to. Importantly, the obsessions described by the parents, and their child if they wish to contribute, must also be considered abnormally pervasive, and disruptive to everyday function. The method through which this information in the parental questionnaire will be collected and validated is detailed in background, efficacy, and the specific facets borrowed from prior literature, below.

Prior studies of obsessions in AS have used different types of questionnaires to assess certain facets of obsessions, and their characteristics. Baron-Cohen & Wheelwright (1999) utilized the Cambridge University Obsessions Questionnaire in order to determine the domain under which the content of each child's obsessions fell. Although this aided in understanding their obsessions as far as their content, it only went as far as to determine the *domain* of the the content. For the present study, this questionnaire would be insufficient due to the lack of information it produces regarding the *exact* obsession the individual child holds. Only a few questions from the Cambridge University Questionnaire will be used in the parental obsession questionnaire, for this study. This portion of the questionnaire will ask parents :"for each category of obsession, please tick whether your child has ever had an obsession in". Only items one (Machines, how things work), two (systems), seven (strongly attached to a particular item), 10 (factual information), and 20 (other) from the Cambridge University Obsessions Questionnaire will be included, for parents to report on.

Another study sought to compare the obsessions experienced by ASD individuals to those experienced by OCD individuals, by comparing the scores of an ASD group to an OCD group (Russell, 2005). These scores were attained through the Yale Brown Obsessive-Compulsive Scale (Y-BOCS) and Symptom Checklist (Y-BOCS-SC). Only genuine obsessions and compulsions were assessed, as to separate these from the usual stereotypic behaviors often displayed by ASD individuals. They asked each ASD participant to define what they understood an "obsession" to be. This was asked because ASD individuals often don't understand the true extent and effect of their obsessions. Symptoms were also only rated if they caused distress and dysfunction in the subject's everyday functioning. While this study's findings were reliable, the only aspect borrowed from this it will be the use of the Y-BOCS and the question of what the participant defines as an "obsession". Furthermore, instead of asking participants to define what an obsession is, only the parents of the participants will be asked to do so.

The Y-BOCS was created in order to assess the severity and types of symptoms experienced by those with Obsessive Compulsive Disorder. It does not directly address nor assess the content of the obsessions and compulsions. It is also written such that comorbid symptoms of other disorders are not considered or reported on (Goodman et al., 1989). It has been used both as a self-report scale (Russell, 2005) a clinician rated scale (Goodman et al., 1989), and an observer rated scale (Scahill et al., 2014). It includes 10 items, with each item rated zero (no symptoms) to four (extreme symptoms). Therefore, a higher numerical score correlates with a higher rate of symptom and illness severity. The total score is obtained by summing up items one through 10. This sum is ultimately the score, and will be anywhere from

zero to 40. While items one through five assess obsessions in OCD, items six through 10 asses the compulsions in OCD. These symptoms are assessed by how much they: interference with normal functioning, cause subjective distress, occupy patient's time, are actively resisted by the patient, and how much the patient can actually control them (Goodman et al., 1989). The scores reveal the average of each item, over the course of one week. This study will only ask parents to fill out items one through five on the the child-friendly version Y-BOCS, the details of which are discussed below. Items one through five specifically pertain to obsessions rather than compulsions, which are not relevant for the study at hand. The Y-BOCS has been used to study obsessions and compulsions in children, as well as children with ASD. Since its creation, there are many alternative versions meant to directly examine a variety of very specific populations.

While the Y-BOCS has proven to be a valid measure of symptom severity in adults with OCD, the question of how well it assessed children with OCD still remained. As there are child-friendly versions of many well founded measures, scales, and instruments, Scahill et al., (1997) sought to test a newly founded child-friendly version of the Y-BOCS. The Children's Yale-Brown Obsessive Compulsive Scale (CY-BOCS) proved to be both reliable and valid in its measurement of symptom severity in OCD children and adolescents. The only reason that the study at hand will not utilize the entire CY-BOCS is due to the fact that ASD children are not fit to accurately report on their obsessions, and this scale is specifically meant for children to report on. The only section of the CY-BOCS that will be borrowed is the Target Symptom List for Obsessions. Here, parents will list in order of severity, the obsessions held by their children. Similar to the items one through five on the Y-BOCS, items one through five from

the CY-BOCS will be included in this questionnaire as well. While the CY-BOCS is sound in its assessment of OCD symptoms, research set out to determine whether it could be used to measure obsessive/compulsive traits in ASD specifically.

Prior literature has also attempted to render a version of the Y-BOCS that calculates the repetitive behaviors in ASD. Scahill et al., (2014) labeled this version of the Y-BOCS as the "Children's Yale-Brown Obsessive Compulsive Scale for Autism Spectrum Disorder" (CY-BOCS-ASD). This version only contained the five items related to compulsion. They also made minor changes to the severity scales, as well as added new items to the compulsions checklist. They kept most of the original items, added in combinations of original items, and gave blank space to add in handwritten items. To avoid duplication or similarity bias, similar items on the scale were collapsed. They labeled their procedure as a "semi-structured interview", in which the parent is the primary informant. Their children were encouraged to engage as well, to the best of their abilities. The professional multidisciplinary experimenters served as interviewers/raters of the participants. They used a checklist to note current symptoms. There was also an area to write "other", if behaviors exemplified by participants seemed to be relevant to the category of compulsions they were assessing. An absence of a mark indicated that there was an absence of that behavior or pattern, in the participant. Overall, their findings on the altered Y-BOCS scale proved to efficient and statistically significant. While this finding supports the foundation of a new Y-BOCS scale for ASD, it does not directly assess the *obsessions* in ASD. Some of the framework used in Scahill et al., (2014)'s rationale will be borrowed for the study at hand, but instead the aim here is to specifically address the obsessions, rather than compulsions, held by ASD individuals. In turn, the primary

aspect that will be borrowed from the CY-BOCS-ASD is the opportunity for, and encouragement of, child participation within the interview.

It has been established that children with ASD are not fully aware of the extent to which their obsessions affect their daily functioning (Boyd et al., 2006). Due to this nature, alterations have been made to the CY-BOCS so that it includes a parental report. Storch et al., (2006) sought to create and test the reliability of child and parent-report formats of the CY-BOCS severity items. They labeled the child-report as the "Children's Yale-Brown Obsessive-Compulsive Scale - Child report" (CY-BOCS-CR), and the parent-report as the "Children's Yale-Brown Obsessive-Compulsive Scale - Parent Report" (CY-BOCS-PR). They used OCD children as their participants, not ASD children. The results revealed the sound and reliable qualities of both the CY-BOCS-CR, and the CY-BOCS-PR (Storch et al., 2006). The only aspect of this study that will be implemented in the study at hand, is the CY-BOCS-PR, or the parental report. The parental report will be altered to feature the severity scales for obsessions only, and disturbance scales for obsessions only. These scales include subsections as well. The severity scale will include subsections for interference, frequency, distress. The disturbance scale will include subsections for resistance and control. All items range from one to five, just like the original CY-BOCS-PR. The wording of the CY-BOCS-PR will also be slightly altered. During the time that the parents of the participants fill out the altered version of the CY-BOCS-PR, the children will be asked to step outside of the interview room in order to get an unbiased answer from the parents, while the child is not present.

Newly created parental questionnaire. Before delving into the details of the newly altered parental questionnaire, the clinician's involvement in its administration must be

discussed. Their involvement during this questioning period is crucial. The clinician will have a copy of the same questionnaire that the parents have, and this version is titled "Parental Questionnaire - Clinician". Their version will include verbal prompts. These prompts are included in the clinician's version in order to instruct the parent and accompanying child on how to fill out the questionnaire. The clinician's responsibility is also to facilitate the transition between the different sections of the parental questionnaire. See Appendix D the clinician's version of the parental questionnaire.

In conclusion, a variety of measures, ideas, and checklists will be borrowed from the studies previously mentioned (Goodman et al., 1989; Baron-Cohen & Wheelwright, 1999; Scahill et al., 1997; Storch et al., 2006; Scahill et al., 2014). Firstly, the parents of the participants will still be asked to define the meaning of "obsession(s)". The clinician will then read off what the CY-BOCS defines as "obsession(s)". Next, only specific parts and items of the CY-BOCS and the CY-BOCS-PR, that truly reflect the nature of obsessions, will be included in this questionnaire (Goodman et al., 2007). The first being the Target Symptom List for obsessions on the CY-BOCS. This list will ask the parent to describe, listing in order of severity, their child's most severe obsessions. Originally, this was meant for the participant to fill out with their parent. Again, only parents will be asked to fill out the parental obsessions questionnaire. At most, the child will be encouraged to speak up if they feel the need to contribute during it's administration. The Target Symptom List will only render a score of one on the parental questionnaire. A following question towards the end of the questionnaire addresses the exact content of the participant's obsession more directly than the Target Symptom List. The second section that is included here is the first half of questions on

obsessions (items one through five), on the CY-BOCS. These items cover what parents can report about their children, on: time occupied by obsessive thoughts, obsession-free intervals, interference due to obsessive thoughts, distress associated with obsessive thoughts, resistence against obsessions, and the degree of control over obsessive thoughts. Again, scores in this section reflect the average of each item, over the course of one week (Goodman et al., 2007). During this time, the child participant will be encouraged to contribute if they feel the need to do so. Following this, children will be asked to leave the room and parents will fill out the newly rendered version of the CY-BOCS-PR. Here parents are able to report on the severity and disturbance of the obsessions. While repetitive of items one through five of the CY-BOCS they previously answered, it's important to note what parents ratings without their child present/able to contribute.

After the parents have filled out this first portion, their child will be asked to return to the interview room. The parents will then be asked to indicate under which core cognitive domain their children's obsessions fall under. Again, the child is encouraged to participate if they wish to contribute. This questionnaire will only use items one (Machines, how things work), two (systems), seven (strongly attached to a particular item), 10 (factual information), and 20 (other), from the Cambridge University Obsessions Questionnaire (Baron-Cohen & Wheelwright, 1999). Lastly, parents will be asked to mark whether their children are obsessed with specifically either clocks, or trains. While the original advertisement for this study will indicate that it only intends to use AS children obsessed with either clocks or trains, these questions solidify the exact content of the participant's obsession.

Due to the fact that this parental questionnaire was designed and created for this study, the cutoff scores for inclusion in the study will not be based in prior literature. For the target list, the only final score possible is a one, as parents should only fill the top obsession with either "clocks" or "trains", as the primary content of their children's obsession. For the following section entitled "Questions on Obsessions (Items 1-6)", the only answers counted towards the final score are those of either "severe" and "extreme", or answers three and four. The only item that differs in answer terminology is item six. Here, the only answers counted towards the final score are those of either "little control" and "no control", or answers three and four. Participants only mark one option on each item. Therefore, the final score possible for this section is six. For the following section entitled "CY-BOCS-PR (altered, Items 7-11)", the only answers counted towards the final score are those of either "severe" and "extreme", or answers three and four. Participants only mark one option here. Therefore, the final score possible for this section is four. For the following section entitled "Cambridge University Obsessions Questionnaire (Altered, items 11-15)", the only answers counted towards the final score are "yes". Item 15, indicating "other" as an obsession category, will not be counted toward the final score. Therefore, the final score possible for this section is four. For the following section entitled "Exact Content Of Obsession", the only answers counted towards the final score are "clocks" or "trains". Therefore, the final score possible for this section is one. Parents who mark that their child is "obsessed with both clocks and trains", or "neither clocks nor trains" will be not be included in the study. The total possible answers that can count towards the final score on the Parental Questionnaire is 28. The expected mean is 24, and the

cutoff score for inclusion is 21. See Appendix D for the parent's version of the parental questionnaire.

The cambridge mindreading face-voice battery test (CAM). The Cambridge Mindreading Face-Voice Battery test is a valuable tool that is implemented in order to test a variety of different ways in which participant's recognize complex emotions. In addition, participant's performance on the Cambridge Mindreading Face-Voice Battery Test (CAM) has been widely used in emotional/facial recognition literature (Golan, Baron-Cohen, & Hill, 2006; Hedley et al., 2011; Duchaine & Nakayama, 2006). The CAM assesses the participant's ability to recognize 20 complex mental and emotional states. It's efficacy was tested by (Golan et al., 2006), who used adults males and females who diagnosed with AS. They compared the test scores of these adults to those of matched healthy controls. While this study had some peculiar gender differences between groups, males with AS had significant difficulty with recognizing faces and emotions.

The cambridge mindreading face-voice battery test for children (CAM-C). To better predict the outcome for children on this test, (Golan, et al., 2015) created a new battery of tasks that more directly assess complex emotion recognition, in children. This measure is called the Cambridge Mindreading Face-Voice Battery for Children (CAM-C). The completion of the CAM-C takes about 45 minutes. They claim that other batteries use static images, and rarely incorporate complex emotion (Golan, et al., 2015). The CAM-C specifically utilizes both visual and auditory tasks, and emotional concepts, to assess an assortment of complex emotions. These emotional concepts include: *amused, bothered, disappointed, embarrassed, jealous, loving, nervous, undecided*, and *unfriendly*. These specific emotional concepts were

included due to the fact that they are developmentally significant, are subtle variations of basic emotions that include a mental component, and are vital to everyday social functioning. The test is comprised of a Face task, a Voice task, and an Emotional Concept task. For the Emotional Concept task, three faces and three voice items were combined in order to convey that emotional concept. Using emotional taxonomy, they created three foils for each item. These foils were at easier levels than the target emotion, or at the same developmental level as the target emotion. As for the Face task and the Voice task, each one started with an instructional slide. Following, participants were asked to select the answer that best describes the emotion that the person in the clip is feeling. Then they were presented two practice items. For the Face task, each clip was followed by 4 emotion labels, presented in a random order. For the Voice task, the 4 emotional labels were presented before and while each auditory clip was played. This was done to prevent the possibility of working memory overload. (Golan, et al., 2015) went on to complete a pilot test with 16 children from age groups ranging from eight to 11 years old. There was an experimental group that consisted of children with ASD, and a control group of children that consisted of neurotypical children. Each task was played to them from a laptop computer. For the Voice task, children were given headphones to listen. They were also read the instructions and possible answers, by the experimenter. They were also given a definition sheet for all of the emotions tested, which remained nearby if it was needed during testing. Lastly, participants were told to select a number (one through four), by which they indicated their answer for which emotion best fits the one just displayed in either the Face or Voice task. The way in which Golan et al., (2015) calculated the scores for emotional concept was by observing whether or not at least four of the concept's six items were marked

correctly. The way in which they calculated the scores for the face test and voice test simply involved tallying the amount of correct answers for each task. Results revealed that the ASD group produced a standard deviation of 3.9 for their scores on the Face task, and a standard deviation of 3.6 for their scores on the Voice task. Their calculations on the recognition of emotional concepts revealed the the ASD group had issues recognizing these specific emotional concepts: *unfriendly, jealous, disappointed, jealous, nervous, bothered, confused.* Importantly, Golan et al., (2015) note that neurotypical children begin verbally labeling as well as recognizing complex emotions by seven years of age. Here is is clear via the results as well as prior findings on the development of complex emotion recognition, that the ASD group had far more difficulty with complex emotion recognition on the CAM-C than the neurotypical control group did.

Altering the CAM-C. The CAM-C will be refined and altered for the sake of continuity between intervention and test material, for this study. Firstly, the computation of emotional concept will not be completed in this study. Secondly, only specific questions/items from both the Face task and the Voice task will be selected for this study. These questions include all items on the original CAM-C that refer to these four complex emotions: *unfriendly, jealous, amused, bothered.* Lastly, only the correct answers from the Face task and the Voice task will be considered in the statistical analysis, unlike Golan et al., (2015) who went on to compute these correct answers in terms of emotional concepts. In conclusion, participants will have a total possible score of 12 on the Face task, and 12 on the Voice task, unlike the original CAM-C. This also means that participant's final score on the altered CAM-C in this study will be out of a total of 24 questions, unlike the original CAM-C. Furthermore, goodness-of-fit tests

will not be run in order to calculate the emotional concepts recognized by each participant. This is not completed because this study is only testing the recognition of four specific emotions, and excluding the testing of the other emotions and emotional concepts in the original CAM-C. Although these changes will not directly reflect the exact findings from Golan et al., (2015) regarding the percentage of correctness for each exact emotional concept, findings on this aspect will be borrowed in the interpretation of proposed results regarding how well each the participants recognize each individual emotion on the Face and Voice tasks. The reasoning for these alterations is detailed below, in a section entitled "Exact Alterations to *The Transporters* to Fit the Altered CAM-C". The completion of the newly altered CAM-C is proposed to take about 20 minutes. For the sheet of correct answers and item numbers for both the Face and Voice CAM-C tasks, see Table 2 and Table 3 in Appendix E. The download link for the original CAM-C can be found in the Works Cited section ("ARC Tests", 2017). All further reference to the use of the CAM-C will be in reference to the altered version of the CAM-C that was created for this study.

The transporters intervention. In 2009, Simon Baron-Cohen and his colleagues designed *The Transporters* (Baron-Cohen, Golan, & Ashwin, 2009). *The Transporters* was an intervention that tapped into the abilities of children with AS by having highly reliable and predictable systems and networks at it's basis. It was a three-dimensional children's animation series. There were different episodes that addressed and focused on a key emotional or mental state. The emotions addressed in each episode included six 'basic' emotions, emotions that are complex but important for development, and emotions that are central to everyday social function. The episodes displayed a variety of different mechanical vehicles, with superimposed

human faces on them. These faces were included in an attempt to help children generalize the abilities they acquired through the intervention, to the context of the real social world. The faces were also included to aid children in facial recognition, which is closely linked to the ability of recognizing emotion. The vehicles interacted within the setting of a little boy's bedroom, to aid familiarity and comfort for the child participant. See Image 1 in Appendix F for an example of the vehicles and superimposed human faces used in the original *The Transporters*. According to Simon Baron-Cohen's "hyper-systemizing" theory (Baron-Cohen et al., 2009), children with ASD would feel more comfortable with vehicles whose motion was determined only by physical rules. Therefore, vehicles whose motions were determined only by physical rules were included in the intervention. The vehicles included two cable cars, a tractor, a chain ferry, a coach, two trams, and a funicular railway. These particular vehicles were chosen because they were Autism-friendly; the way in which they moved in space (back and forth) is understood and preferred by children with ASD. There are also quizzes available within *The Transporter's* DVD menu, but these quizzes will not be used in the current study. Furthermore, the videos included narration that described the context and situation in which the each emotion would likely take place (Golan et al., 2009). This was included in an attempt to aid children in generalizing what they have learned to the real social world. While the theoretical basis for this intervention is highly grounded in previous literature, the results from Golan et al., (2009) reveal its adequacy and rate of success.

A review by Baron-Cohen et al., (2009) reviewed and detailed an experimental study that investigated the efficacy of *The Transporters* (Golan et al., 2009). This study utilized three groups: Autism Spectrum Conditions (ASC) experimental/intervention group, ASC control

group, and a neurotypical control group. These groups were assessed at two different times. Time one was at the start of the experiment, and time two was one month after time one. Each assessment tested participants for four levels of generalization. One level addressed emotional vocabulary, while the other three addressed one's ability to match socio-emotional situation to a applicable/probable facial expression. The results showed that after time one, there were significant differences between the two clinical groups (ASC-control & ASC-intervention) as compared to the neurotypical control group, on emotional vocabulary task and the three situation-expression tasks (Baron-Cohen et al., 2009; Golan et al., 2009). After time two, the ASC intervention group displayed significant progress across between times one and two, across all task levels. Further bolstering these results, the ASC-control group as well as the neurotypical control group showed no significant improvement between times one and two, across all task levels. While the findings for the ASC groups after time one demonstrate their well defined deficit, they also exemplify the efficacy of the intervention (Golan et al., 2009). As implied by Weak Central Coherence theory, people on the autism spectrum have an inability to understand emotions caused by belief. Belief is highly contextually dependent (Hill, 2004). As mentioned before, *The Transporters* utilized narration that detailed the label of the emotion, as well as a context in which this emotion would take place. Therefore, the ability to generalize the understandings derived from this intervention also exemplifies a strengthening of the understanding of the connections between context, belief, and emotion. These results also reveal that the use of ASC-friendly environments and characters was appealing to them, and therefore more efficient in capturing their attention. Parental anecdotal reports further backed this intervention. The parents of ASC-intervention group reported that

their children were more willing to talk about emotion, and were more captivated by facial expression. They also noticed a significant difference in their children's ability to interact socially with other people (Baron-Cohen et al., 2009; Golan et al., 2009).

***Altering the transporters*.** This study intends to alter *The Transporters* to feature solely the content of two specific obsessions. The first obsession being trains, and the second obsession being clocks. This altered version will still use the trains used in *The Transporters*. These trains are vehicles that move on a two way track, aiding predictability and lessening the chance of human error. In order to lessen possible bias or confounding variables of commonality, this study will also include clocks as the objects that interact during each episode. This decision was made due to the highly similar nature of the original vehicles used on *The Transporters*: trains, trams, and trolleys. Again, the main objective in designing the intervention for this study is to create a highly individualized and specific stimulus that the participant is notably obsessed with. Thus, using the original vehicles shown in *The Transporters* could possibly create too much similarity between stimuli, and therefore skew the results.

The original stimulus that *The Transporters* utilized will be altered to only feature trains. The purpose of this is to create material for the obsession-specific (OBS) intervention, for the group of participants obsessed with trains (AS1). The OBS condition is detailed in a section below entitled "Obsession Specific Condition - OBS". The material for the train OBS condition will feature solely trains. All other vehicles that were originally featured will be eliminated from *The Transporters* DVD in this study. The trains will be part of a large train set in a child's bedroom. Each train will be a different color. Just as the original *The Transporters*

intervention, superimposed human faces will be grafted on to the trains. These different trains will conversate in a social context in order to teach/relay the specific emotion of each episode. Additional computer generated stimulus will be created in order to provide material for the Obsession Specific (OBS) condition, for the group of participants obsessed with clocks (AS2).

The material for the clock OBS condition will be feature a variety of different types of clocks that are placed in different parts of a little boy's house. Examples of these different types of clocks include a: cuckoo clock, sundial clock, master clock, pendulum clock, paper clock, and a rolling ball clock. The cuckoo clock will be placed in the child's bedroom. The sundial clock will be placed in the child's front yard. The master clock will be placed in the child's living room. The pendulum clock will be placed in the child's kitchen. The paper clock will be placed in the child's play room. Lastly, the rolling ball clock will be placed in the parent's home office. Just like the trains, the clocks will feature superimposed human faces that conversate in a social context in order to teach/relay the specific emotion of each episode.

Lastly, the quizzes included in *The Transporters* DVD menu will not be utilized in this study. Instead, this study will implement the completion of the CAM-C, in order to assess the facial and emotion recognition abilities in the participants pre and post intervention.

Commonalities between the transporters and the CAM-C. The CAM-C is suitable to test *The Transporters* considering that both employ a motion video format, a narrator to draw attention to context and situational factors, and describe/test for complex emotion. There are a few complex emotions that are taught in *The Transporters* that are also tested similarly by the CAM-C. It is important that the test of facial/emotional recognition in this study is able to test the precise emotions that *The Transporters* conveys in each episode. Golan et al., (2015)

mentions that children with ASD have most difficulty with six specific complex emotions that the CAM-C tests. These emotions include: *disappointed, jealous, nervous, unfriendly, bothered, amused*. *The Transporters* also happens to feature episodes that convey two of these same emotions: *jealous* and *unfriendly*, while also featuring episodes that convey very similar emotions as those mentioned above. These episodes, containing/relaying emotions that are very similar to those that AS children have problems identifying on the CAM-C, will be altered to fit the exact emotion that the CAM-C tests.

Exact alterations to the transporters to fit the CAM-C. In order to properly test for the exact emotions taught in *The Transporters*, the CAM-C must only test the emotions relayed in *The Transporters*. Therefore, any and all questions that do not pertain to to these emotions: *unfriendly, jealous, amused,* and *bothered,* will be excluded from the CAM-C. The episodes of *The Transporters* that originally taught the emotions of: *joking* and *ashamed*, will be altered via their vocal dialogue/script as well as their situational context. The episode that teaches the emotion of *joking* will be altered to teach the emotion of *amused*. The episode that teaches the emotion of *ashamed* will be altered to teach the emotion of *bothered*. Thus, the exact emotions taught in *The Transporters* will also be tested by the CAM-C, which only features questions that test those specific emotions as well. If necessary, refer to Table 2 and Table 3 in Appendix E once more for the emotions tested, item numbers, item order, and correct answers within the CAM-C face and voice tasks.

Tobii pro X2-60 eye tracking technology. The computer screens through which participants view their designated intervention conditions will feature state of the art eye tracking technology. This eye tracking technology serves to equate and calculate the fixation

durations for each participant, while they view the intervention. The system that will be used Tobii Pro X2-60. This system has a sampling rate of 60 hz ("Tobii Pro X2-60 screen-based eye tracker", 2017). It is easily mountable on almost any screen, including cell phones. It uses a variety of eye tracking metrics, but this study will specifically utilize it to observe fixation durations. It also limits the need for recalibrations by providing stable and dependable eye tracking calibrations.

Procedure

Baseline Measures and Consent Forms

After recruitment, all participants and their parents will come into a kid-friendly lab setting in order to complete the consent forms, and all of the baseline measures. See Appendix G for the consent form sheet. Consent forms and baseline measures will be administered and monitored by eight clinicians, such that each clinician will work with a total of 10 participants. The baseline measures will include: WISC-V, CAST, AQ-Child, and the parental questionnaire. The baseline measures are completed by the participant's parents, for the most part. The only baseline measure completed by only the participant themselves is the WISC-V. After completing the baseline measures, scores will be calculated accordingly. Any participants that do not fall within the cutoff scores will not asked to return. See Table 4 in Appendix H for predicted means and cut-off scores for baseline measures. They will then be given their assigned intervention DVD's.

Group and Condition Assignment

As mentioned in the "Design" section, participants will be divided into two original groups: AS1 (obsessed with trains), and AS2 (obsessed with trains). Afterwards, these two

original groups will be randomly divided into a total of 4 subgroups (AS1A, AS1B, AS2A, AS2B). Each of the two subgroups from the original groups will be randomly assigned to either the OBS condition, or the N-OBS condition. Refer once more to Table 1 in Appendix A for the layout of group/condition assignment, and the number of participants in each group.

Obsession Specific Condition (OBS)

The Obsession-Specific (OBS) condition is comprised of the altered version of *The Transporters* that features either trains, or clocks. This condition is meant to provide the participant with an intervention that is tailored to their exact obsession. For example, if a participant from AS1 is randomly assigned to the AS1A subgroup, they will participate in the OBS condition. This means that they will view an intervention that features solely trains. If a participant from AS2 is randomly assigned to AS2A, they will participate in the OBS condition as well. Due to their specific obsession with clocks, they will view an intervention solely features clocks.

Non-Obsession Specific Condition (N-OBS)

The Non-Obsession Specific (N-OBS) condition is also comprised of the altered version of *The Transporters* that features either trains, or clocks. This condition is meant to provide the participant with an intervention that is *not* tailored to their exact obsession. For example, if a participant from AS1 is randomly assigned to the AS1B subgroup, they will participate in the N-OBS condition. This means that they will view an intervention that features solely clocks. If a participant from AS2 is randomly assigned to the AS2B subgroup, they will view an intervention that features solely trains. The dialogue, emotions taught, and social situational contexts are the same for both the OBS and N-OBS conditions. The only difference

is that the OBS condition is tailored to the participant's specific obsession, while the N-OBS condition is not.

Overall Duration, Pre Intervention CAM-C, and Intervention Viewing Period

This study will take a total of 16 weeks and three days. After the initial baseline conditions are completed and met, participants will return the next day to complete the CAM-C. This will be administered by research assistants. There will be a total of 20 research assistants, such that each research assistant administers the CAM-C to four participants throughout the day. Upon completion, participants and parents will receive their assigned episodes of *The Transporters*, from the research assistants. There will be time given for participants and parents to voice their questions and concerns. Participants and parents will be instructed to watch their first assigned episode, the day after they complete the CAM-C and receive their DVD's. Once a week, participants will continue to view their assigned episode with their parents. This will continue for four months, or 16 weeks. The altered version of the *The Transporters* only features four episodes that relay four specific emotions emotions: *unfriendly, jealous, amused, bothered.* Each episode for each emotion will be viewed a total of four times. Blocked randomization will be implemented when ordering the lineup of the episodes, to insure that no episode is repeated consecutively, and such that repetition of an episode will only occur after all four episodes are viewed at least once, and so forth. Episodes are repeated in order to appease the "need-for-sameness" and "change resistance" in AS (American Psychiatric Association, 2013). Refer to Table 5 in Appendix I for the randomly generated order of episodes/emotions taught throughout the 16 week intervention viewing period.

Amount of parental involvement during intervention viewing. While the overall goal is to get the participant to engage with and understand the material of each episode, parental involvement during each viewing has proven to aid their progress (Golan et al., 2009). Golan et al., (2009) mentions that parents and carers were supplied with a detailed guide to *The Transporters* DVD. They also were instructed on various way in which they could facilitate their children's learning experience. For example, they were told to encourage their children to repeat episodes if they felt the need to do so. They also encouraged parents to help broaden their children's understanding of the theme and emotion of each episode, by engaging in a dialogue after viewing the episode. If the verbal ability of the child permitted, parents were also asked to question their child on the further implications, situations, and different perspectives that could be involved which the specific emotion taught in the particular episode just viewed. Lastly, parents were told to encourage their children to pay attention to the facial expressions and social situations depicted in each episode. This is suggested in order to attempt to incorporate Theory of Mind into their child's learning experience. This amount of parental involvement will also be used in this current study. Although variable, parental involvement is crucial during and shortly after each episode. Possible limitations of this parental involvement are discussed in the "Limitations" section below.

Post Intervention CAM-C and Debriefing

After this 16 week period, participants come back into the kid-friendly lab setting and complete the CAM-C once more. This test will again, be administered by the research assistants in the same fashion as they did pre intervention. After this time point, the pre and

post intervention CAM-C scores will be available for interpretation, as they depict the participant's change in facial/emotional recognition ability over time.

After participants have completed the 16 week intervention viewing period and their pre and post intervention CAM-C scores are obtained, parents and children will receive a debriefing form. Any final questions they might have will be answered by research assistants. Refer to Appendix J for a proposed timeline of the procedure and data collection. Refer to Appendix K for the debriefing form. Refer to Appendix L for the proposed budget for this study.

Data Preparation

Main Statistic - Time x Obsession Match x Video Type

While this study is proposed, the statistical procedure and design is important in the computation and understanding of the proposed results. This study will adopt an alpha level of 0.05. The main statistic for this study calls for a mixed design 2x2x2 ANOVA. Before running the this statistic, some testing of assumptions is necessary. For assumptions of normality, a test for skewness and kurtosis is necessary. For homogeneity of variance-covariance, a Box's M test is necessary. It is assumed that the data will meet these assumptions, based on prior literature (Golan, Sinai-Gavrilov, & Baron-Cohen, 2015). The next step is to run the 2x2x2 mixed design ANOVA. For this test, there is one dependent variable as well as two independent variables. The dependent variable is Time, with two sublevels of pre intervention and post intervention. The content of the pre intervention data will include the pre intervention CAM-C scores for all participants, and the content for the post intervention data will include

the post intervention CAM-C scores for all participants. Therefore, the first independent variable is Obsession Match, with two sublevels of Obsession-Matched and Non-Obsession Matched. The second independent variable is Video Type, with two sublevels of Train and Clock. For the variable of Video Type, the subgroups (AS1A, AS1B, AS2A, AS2B) will be collapsed back to the original groups of AS1 (obsessed with clocks) and AS2 (obsessed with trains). Expectations regarding the proposed results for this main statistic are detailed in the section below entitled "Proposed Results".

A follow up statistical procedure is needed to investigate the proposed interaction between Obsession Match and Time (see "Predicted Results" section below). Here, an independent samples t-test would best suffice. There are no predicted differences between Video Type and Time, so no test is necessary for this aspect of the design.

Secondary Statistic - Attention x Obsession Match x Video Type

Another aspect of the study includes the fixation durations (attention to) the intervention stimulus. This aspect calls for another mixed design 2x2x2 ANOVA. As mentioned above, this data must fit the assumptions of an AVOVA. For assumptions of normality, a test for skewness and kurtosis is necessary. For homogeneity of variance-covariance, a Box's M test is necessary. It is assumed that the data will meet these assumptions. For reasoning behind this statement, refer to the "Fixation Duration Quantification - Assumptions of Normality" section below. After completing these tests of assumption of normalcy, the next step is to complete the mixed design 2x2x2 ANOVA. For this test, the dependent variable is Attention, which has two sublevels of long fixation durations (LFD) and short fixation durations (SFD). The difference between and cutoff scores

for these two sublevels is detailed in the chapter entitled "Fixation Duration Quantification - Long vs Short Fixation Durations". The first independent variable is Obsession Match, which has two sublevels of Obsession-Matched and Non-Obsession Matched. The second independent variable is Video Type, which has two sublevels of Train and Clock.

A follow up statistical procedure is also necessary to investigate the proposed interaction between Fixation Duration and Obsession Match (see "Predicted Results" section below). This aspect calls for an independent samples t-test. There are no predicted differences between Video Type and Time, so no test is necessary for this aspect of the design.

Fixation duration quantification - assumptions of normality. Due to the complex and original nature of this study, the quantification of fixation durations is difficult. Prior research suggests that the auditory and visual stimulus produced by a the viewing of a video episode yields similar results as far as fixation duration and attention go. The episodes of *The Transporters* that the participants view do feature video material that is meant and proven to be autism-friendly (Young & Posselt, 2011). There is also evidence that ASD individuals pay more attention to their objects of interest/objects of obsession (Boyd et al., 2006). Prior research is sparse in the direct subject area of ASD and it's relation to fixation durations and attention. Due to the lack of empirical backing in this subject area, studies that observed fixation durations, eye-movements, and attention while viewing a variety of stimuli will be cited. An initial question would be whether or not the participants will give any visual attention to the intervention, whatsoever. Pannasch, Schulz, & Velichkovsky (2011) found visual change, which includes its onset and offset, perpetuates ongoing visual fixations. Thus a stimulus in the format of a video, which includes moment-to-moment visual change, will at

least catch the participant's attention and perpetuate their fixation durations. Fixation durations and areas of visual processing are also tightly linked. Castelhano, Mack, & Henderson (2009) had participants view colored photographs of natural scenes with two areas of visual processing in mind: visual search and memorization. These areas were tested in two separate tasks. Their results showed that fixation durations remained consistent across these two tasks which required different areas of visual processing. In addition, Rayner (1998) mentions that in simple visual discrimination tasks, the locus of eye location and attention are easily isolated. Yet when it comes to complex visual information processing tasks, the two are actually quite closely associated. Here the assumption could be made that the complex visual involved with video episode viewing in this study would likely display the same tight link between eye location and attention. Furthermore, d'Ydewalle, & Gielen (n.d.) suggest that the act of watching a television requires the processing of at least two channels of information: auditory and visual. They go on to explain that these two areas are "partially redundant: they do not contradict but rather supplement one another, or express the same content in a different form" (d'Ydewalle, & Gielen, n.d.,). The combination of findings from each of these studies leads to the semi-verified assumption that the raw fixation duration data will meet tests of assumptions of normality. The findings also demonstrate the tight link between fixations and attention.

Fixation duration quantification - long vs short fixation durations. The statistical procedure necessary for the aspect of fixation duration/attention in this study is a mixed design 2x2x2 ANOVA. Before completing this statistical measure, it is important to quantify the sublevels of the dependent variable, Attention. These sublevels include Long Fixation Duration (LFD) and Short Fixation Duration (SFD). The proportion of fixation durations during

intervention episode viewing periods involve the participant looking directly at the computer screen that is playing the intervention episode. This exact proportion will not include the proportion of fixation durations where the participant is not looking directly at the computer screen. The eye-tracking device will record all fixation durations, whether they are on or off the screen. All fixation durations on the perimeter of the computer screen will not count towards participant's total fixation duration score. This discrimination is the first step in quantifying the subscales of LFD and SFD. The second step in quantifying these two sublevels involves actually obtaining participant's proportion of fixation on the screen. Each episode of *The Transporters* is five minutes long. Therefore, participant's possible fixation duration score will be out of a total of 80 minutes. This is mathematically explained by simply multiplying five (minutes) by 16 (times they view the intervention). In other words, the amount of time participants fixate solely on the screen will be proportionally compared to the total of 80 minutes they spend viewing the intervention. Due to a lack of existing literature in this highly specified area, cut off scores that will define LFD and SFD will be novel. Participants who score at or above LFD will fixate on the stimulus for at least %80 of the total time (80 minutes), or more (a total of 64 minutes or more, out of the total 80 minutes). Participants who score below the LFD will be categorized as SFD, and will fixate on the stimulus at most %79 of the total time (80 minutes), or less (total of 63 minutes or less, out of the total 80 minutes). When the fixation duration score falls 30 seconds and above the minute mark (eg. a total fixation duration score of 65 minutes and 31 seconds), the fixation duration score will be rounded up to the minute mark above (in this instance, this fixation duration score would be rounded up to 66 minutes). As such, fixation duration scores that fall 29 seconds and below the

minute mark (eg. a fixation duration score of 65 and 28 seconds) will be rounded down to the minute mark below (in this instance, this fixation duration score would be rounded down to 65 minutes). Predicted means for fixation durations and their relation to other data in the 2x2x2 mixed design ANOVA can be found in the section below entitled "Predicted Results".

Proposed Results

Main Statistic Predicted Results

The main statistic for this study is the 2x2x2 mixed design ANOVA that utilizes Time as a dependent variable, Obsession Match as the first independent variable, and Video Type as the second independent variable. There are two main effects that are expected to be the product of this 2x2x2 mixed design ANOVA. The first main effect expected will be the main effect of Obsession Match ($p<0.05$). The second main effect that expected will be the main effect of Time ($p<0.05$). There is also one interaction that is expected to be the product of this 2x2x2 mixed design ANOVA. This interaction is expected to be between Time and Obsession Match ($p<0.05$). This interaction calls for an independent t-test. These tests are also detailed in the section above entitled "Main Statistic - Time x Obsession Match x Video Type". There is no expected main effect of Video Type. There are also no predicted interaction between Time and Video Type, as well as Obsession Match and Video Type.

Importantly, it is proposed that there will be no difference in the recognition, or lack of recognition, of each of the four emotions relayed and tested (*unfriendly, amused, jealous, bothered)*. In other words, no individual emotion is expected yield a significantly higher or lower score on the CAM-C, pre and post intervention.

The independent samples t-test that investigates the relationship between Time and Obsession Match is expected to yield a significant result, with a p-value that is less than 0.05 ($p<0.05$). Refer to Figure 1 below for a pattern of predicted means for Time and Obsession Match. This graph represents the dependent variable of Time as the predicted means of the pre and post intervention CAM-C scores, for participants in both of the conditions. The two differently colored bars represent Obsession Match, as either Obsession-Matched or Non-Obsession Matched. Specifically, the darker colored bars represent participants in the OBS condition, and the lighter colored bars represent participants in the N-OBS condition. This predicted graph implies that participants in the OBS condition had significantly higher post intervention CAM-C score means than the post intervention CAM-C score means for participants in the N-OBS condition ($p<0.05$). It also implies that participants in the OBS condition had a statistically significant difference between their pre intervention CAM-C score means, and their post intervention CAM-C score means ($p<0.05$). It is proposed that participants in the OBS condition's post intervention CAM-C score mean will be significantly higher than their pre intervention CAM-C score mean. To be exact, participants in both the OBS and N-OBS conditions are both predicted to have a pre intervention CAM-C score mean of nine. Participants in the OBS condition are predicted to have a post intervention CAM-C score mean of 21. Lastly, participants in the N-OBS condition are predicted to have a post intervention CAM-C score mean of 12.

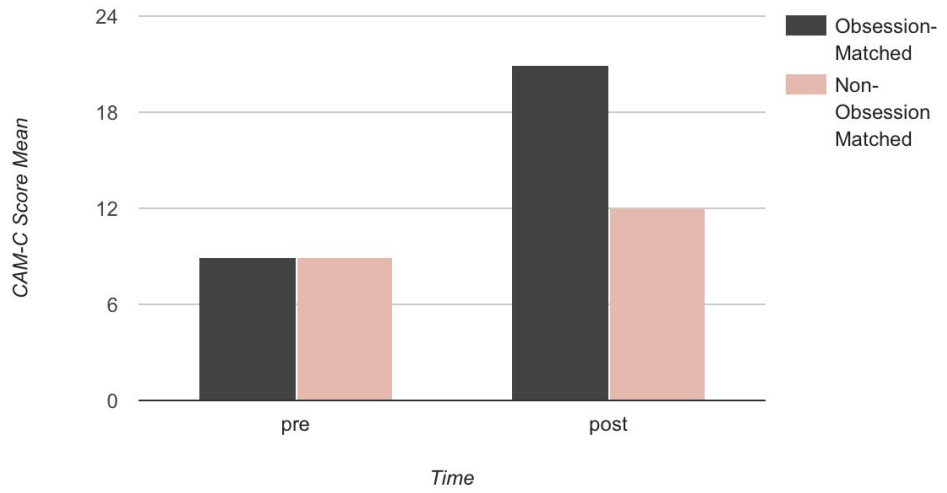

Figure 1. The expected pattern of results for predicted means of CAM-C scores for participants in both the OBS and N-OBS conditions, pre and post intervention viewing period. Participants in the OBS condition are proposed to have significantly higher ($p<0.05$) post intervention CAM-C scores than participants in the N-OBS condition. Participants in the OBS condition are also proposed to have significant difference between their post intervention CAM-C scores and their pre intervention CAM-C scores ($p<0.05$). This significant difference is thought to revel higher post intervention CAM-C scores for participants in the OBS condition, when comparing them to the pre intervention CAM-C scores for participants in the OBS condition.

Another way to track participant's progress throughout time is to observe the difference scores between the predicted means for the pre intervention CAM-C scores, and the predicted means for the post intervention CAM-C scores. In order to create these difference scores, the predicted mean for the pre intervention CAM-C scores will be subtracted from the predicted mean for the post intervention CAM-C scores. This should be completed for participants in both the OBS and N-OBS conditions. The predicted results for participants in the OBS condition are expected to reveal a mean difference score of 12. The predicted results for participants in the N-OBS condition are expected to reveal a mean difference score of three. There is an expected significant difference between the mean difference scores for participants in the OBS condition, and participants in the the N-OBS condition ($p<0.05$). Refer to Figure 2 below for a graph that clearly depicts the predicted pre and post intervention CAM-C mean difference scores, for participants in both the OBS and N-OBS conditions. The darker bar

represents participants in the OBS condition. The lighter bar represents participants in the N-OBS condition.

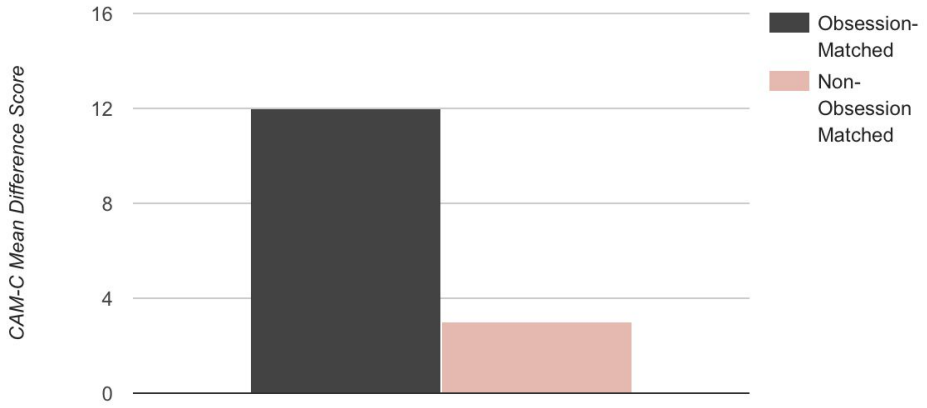

Figure 2. The predicted pattern of results for expected CAM-C mean difference scores between the participants in the OBS condition and the N-OBS condition. These mean difference scores reflect the difference between the expected pre intervention CAM-C score mean, and the expected post intervention CAM-C score mean. The darker bar represents participants in the OBS condition. The lighter bar represents participants in the N-OBS condition. Participants in the OBS condition are proposed to have significantly higher CAM-C mean difference scores than participants in the N-OBS condition ($p<0.05$).

Secondary Statistic Predicted Results

The secondary statistic in this study investigates attention paid to the intervention. This statistic is the 2x2x2 mixed design ANOVA that utilizes Attention as the dependent variable, Obsession Match as the first independent variable, and Video Type as the second independent variable. This statistic is expected to yield the two main effects of Attention ($p<0.05$) and Obsession Match ($p<0.05$). It is also expected to yield an interaction between Fixation Duration and Obsession Match ($p<0.05$).

This expected interaction calls for a follow up independent samples t-test, observing the means of both Attention and Obsession Match. This follow up independent samples t-test is expected to yield a significant difference ($p<0.05$) between Attention and Obsession Match.

See Figure 3 below for the predicted means for Attention (fixation durations) and Obsession Match. This graph implies that a significantly higher amount of participants in the OBS condition are expected to present a fixation duration mean that falls under LFD (long fixation duration), as compared to participants in the N-OBS condition ($p<0.05$). It also implies that a significantly higher amount of participants in the N-OBS condition are expected to present a fixation duration mean that falls under SFD (short fixation duration), as compared to participants in the OBS condition ($p<0.05$). The darker bars represent participants in the OBS condition. The lighter bars represent participants in the N-OBS condition. To be specific, the predicted fixation duration mean for participants in the OBS condition that fall under the LFD sublevel is 69.6. This can also be understood in terms of a mean percentage of time spent fixating on the screen, which comes out to a mean of 87% (out of the total 80 minutes spent viewing the intervention). The predicted fixation duration mean for participants in the OBS condition that fall under the SFD sublevel is 10.4. In terms of percentage, this comes out to a mean of %13 of time spent fixating on the screen (out of the total 80 minutes spent watching the intervention). The predicted fixation duration mean for participants in the N-OBS condition that fall under the LFD sublevel is 30.4. In terms of percentage, this comes out to a mean of %38 of time spent fixating on the screen (out of the 80 total minutes spent viewing the intervention). The predicted mean for participants in the N-OBS condition that fall under the SFD sublevel is 49.6. In terms of percentage, this comes out to a mean of %62 of time spent fixating on the screen (out of the 80 total minutes spent viewing the intervention). Implications of these proposed results are detailed in the "Discussion" section below. Limitations of these proposed results are discussed below in the section entitled "Limitations".

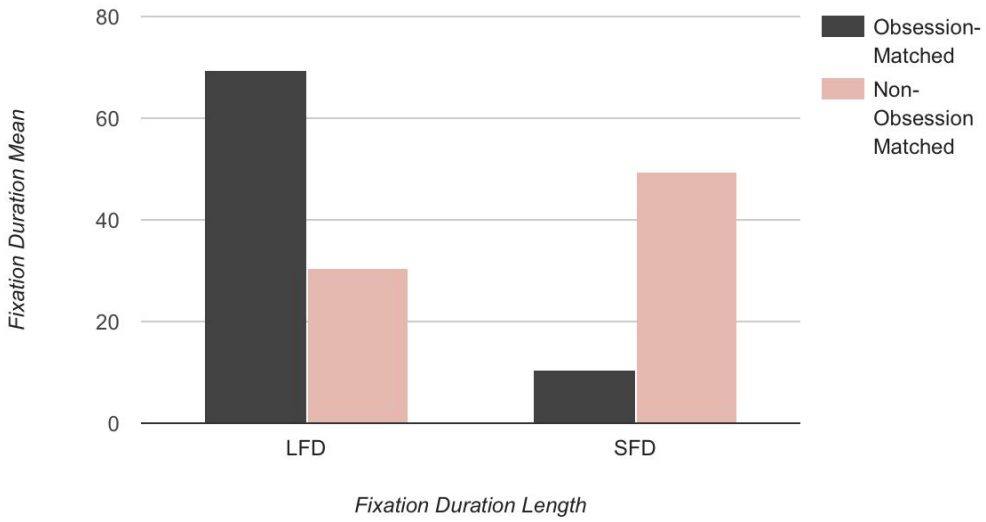

Figure 3. The predicted pattern of results for predicted means for fixation durations during intervention viewing, for participants in both the OBS and N-OBS conditions. Participants in the OBS condition are proposed to have significantly higher fixation duration mean, that falls under long fixation duration (LFD) ($p<0.05$), as compared to participants in the N-OBS condition. Participants in the OBS condition are proposed to have a significantly higher fixation duration mean, that falls under long fixation duration (LFD), than their fixation duration mean that falls under short fixation duration (SFD) ($p<0.05$). As a reminder, LFD and SFD are the two sublevels for the variable of Attention.

Discussion

This study observed the effects that an obsession matched intervention has on the facial/emotional recognition deficit in Asperger's Syndrome. An additional facet of this design involved the attention participants paid to both intervention conditions. The proposed results of this study have many implications that go beyond the immediate findings.

The proposed results reveal that no matter the content of the participant's obsession, those in the OBS condition produce higher CAM-C post intervention scores. This finding concurs with prior research that found ASD individuals value and prioritize their objects of interest/obsession, far more than they do to any facet of socialization (Boyd et al., 2006). This

proposed result also bolsters the efficacy of autism-friendly design of *The Transporters* intervention (Young & Posselt, 2011; Golan et al., 2009). This finding is also supported by prior research that details the necessity for individualized treatment and intervention for children on the autism spectrum, that capitalizes on their abilities (Klin, Volkmar, & Sparrow, 2000). Thus supporting the main hypothesis that a highly tailored and obsession-specific intervention that aims to improve the facial/emotional recognition deficit in AS children could be beneficial in doing so.

The second facet of this study involved the visual attention paid by the participants, to the intervention. Participants who were in the OBS condition were proposed to have a significantly higher amount of fixation duration means that fell under LFD (long fixation duration), as compared to participants in the N-OBS condition. Participants in this N-OBS condition were proposed to have a significantly higher amount of fixation duration means that fell under SFD (short fixation duration), as compared to participants in the OBS condition. This proposed finding is in concordance with studies that demonstrate the devout visual attention given by ASD individuals, to their object of interest/obsession (Klin, Volkmar, & Sparrow, 2000; Sasson, Dichter, & Bodfish 2012; Sasson et al., 2008). Thus, this secondary hypothesis was supported as well. In combination, these findings reveal the promising benefits of an intervention that is tailored to the specific interest of a child with Asperger's Syndrome.

The Transporters was originally designed to be autism-friendly, via appealing to the very particular nature of their processing and functioning style. Baron-Cohen, Golan, & Ashwin (2009) interpret the promising results of Young & Posselt (2011) by noting which aspects of *The Transporters* directly resonate and appeal to ASD individuals. They note that

the intervention pays homage to the hyper-systemization processing style that is highly common in ASD individuals. It also caters to their "need-for-sameness", which is also referred to as their "resistance to change". This was accomplished within the original *The Transporters* by only featuring mechanical vehicles that have a very predictable path of movement; backwards and forwards. It is also proposed that this "need-for-sameness" is what intervenes with their understanding and interpretation of social situations, which by nature are highly variable and unpredictable. While the alterations made to the original *The Transporters* excluded most of the original vehicles, the addition of clocks was proposed to provide the same predictability. Furthermore, episodes were repeated throughout the intervention viewing period in order to appease their "need-for-sameness". Klin, Volkmar, & Sparrow, (2000, p. 384) mention that "many of the special interests that typify AS involve repeating the same facts or rehearsing the same memories, and it can trigger a fury if something has changed...This suggests that one of the benefits of repetition is anxiety reduction." Thus the repetition of episodes of *The Transporters* throughout the intervention viewing period is proposed to not only mitigate their "change resistance" (American Psychiatric Association, 2013), but also possibly reduce their anxiety. By providing an intervention that ASD children are both receptive and attentive to, *The Transporters* was thought to change the way these children interpret the social world around them. Findings from prior research found just that within their highly efficacious results (Young & Posselt, 2011; Baron-Cohen, Golan, & Ashwin, 2009). This study predicted that further modifying this intervention to the *specific* and *individual* content of a subject's obsession could be as, if not more beneficial than the original *The Transporters* intervention.

As previously mentioned, Klin, Volkmar, & Sparrow (2000) include a chapter entitled "Treatment and Intervention Guidelines for Individuals with Asperger's Syndrome". Here it is mentioned that interventions that take advantage of an AS individual's distinct characteristics/processing style, as well as appease their individual needs, will be best fit for those who have the syndrome. It is also noted that in order to do so, clinicians and psychologists should have a "thorough understanding of the specific individual's profile of skills and deficits in areas important for learning, for communicating and relating with others, and for acquiring independent living skills"(Klin, Volkmar, & Sparrow, 2000, p. 340-341). Furthermore, children with AS are often grouped into interventional programs with other ASD children that fall on all ends of the autism spectrum. As previously discussed, AS is on the high-functioning end of the autism spectrum and therefore qualitatively different than other ends and areas of the spectrum. Interventions that group AS children in with other ASD children do not capitalize on their specific abilities and characteristics. The intervention featured in this study is proposed to do so, therefore taking advantage of their abilities and unique processing profile.

As mentioned in the literature review, AS individuals process faces in a piecemeal manner (Katagiri et al., 2012). This study did not perform analysis on eye-movements in order to observe how exactly they processed faces. Regardless, it is proposed that higher post-intervention CAM-C scores in the OBS condition could indicate that the intervention aided participants in processing faces more holistically. This proposed ulterior finding is backed by prior research that indicates the necessity for hollistic processing, in the recognition of facial emotion (Hill, 2004; Hall, Szechtman, & Nahmias, 2003). Future research should

investigate the visual processing style AS participants demonstrate while viewing an intervention that features the exact content of their obsession. This observation should be made while they take the CAM-C as well.

In addition, prior research found that those with AS present a ToM deficit (Li, Kelley, Evans, & Lee, 2010). This deficit can sometimes manifest in a lack of social reciprocity, or a lack of empathy towards others (Ellis & Bjorklund, 2004). The proposed results of this study could be a first stepping stone towards a strengthening of ToM as well as empathy in AS individuals. The bolstering of the ability to recognize complex emotions would likely enhance their capability to share attention, understand other's mental states and how they differ from one's own, and empathize with others. Additionally, it also might aid them in their recognition and understanding of deception. These abilities would only be located and strengthened through follow up ToM training and intervention. As a starting point, implementation of interventions such as the one featured in this study should be utilized throughout the development and lifespan of AS individuals.

While this proposed study only used child participants, future research should consider similar age-appropriate interventions. Adolescence and young adulthood are periods in one's life that involve ample social change, as well as social demands. Examples of these changes and demands include: leaving this house after grade school, applying to and fairing well in college, developing social and professional relationships, developing sexual and romantic relationships, and transitioning from school to work. These aspects of social development and change present arduous challenges to those with AS, while appearing natural and almost effortless to neurotypical people (Klin, Volkmar, & Sparrow, 2000, p. 367). If children with

AS are unable to form social bonds and attachments, it is likely that they will experience this on into adulthood. The continuation of asocial behavior and a lack of social bonding can manifest in problem behavior later on in life. Antisocial behavior is said to lead to problem behavior such as aggression, malice, and outrage. Impaired social relationships are said to lead to problem behavior such as loneliness, and adaption of a marginal lifestyle. Emotional disorders are said to lead to problem behavior such as anxiety, depression, and panic disorder (Klin, Volkmar, & Sparrow, 2000, p. 388). This succession of negative manifestations of the facial/emotional recognition deficit throughout the AS lifespan strongly suggest the necessity and continuation of early intervention.

In conclusion, the proposed findings from this study imply that a facial/emotional recognition intervention that features the exact content of an AS individual's obsession is beneficial to them. The original intervention stimulus was designed specifically for those on the autism spectrum. The further it is adjusted to the individual and to the higher-functioning end of the spectrum, the more appealing and therefore effective the intervention becomes for AS individuals. Starting implementation at a young age is vital, as the demands of the social world become more and more impinging and abundant throughout life.

Limitations

This study was not without limitations. Firstly, there was no neurotypical control group to compare pre intervention CAM-C scores to. This would have supplied a comparison between neurotypical ability and AS ability on the facial/emotional recognition task. Future research should include neurotypical controls as a means for comparison.

Statistical analysis also only allows for so much interpretation. In the proposed statistical plan for this study, there was no post-hoc test implemented in order to compare the pre and post intervention CAM-C scores to the attention paid during intervention viewing periods (LFD, SFD). Furthermore, Figure 3 does not detail the exact number of participants in either the OBS or N-OBS conditions, who had fixation duration means that fell under LFD or SFD. Raw data points were not generated to create this graph, and the computer program used was therefore unable to generate the exact number of participants within each sublevel (LFD, SFD). Future research will be empirical and not proposed, such that raw data will be available and these numbers will be obtainable.

Predicted results mentioned that there was no predicted influence of, or significant difference between, the two video types (trains and clocks). A possible limitation here could involve participants being more obsessed with, devote more obsession-like qualities and behaviors towards, and pay more attention to, either of the two video types. This was not predicted due to findings of devout obsessional behaviors towards and about objects of interest (also known as circumscribed interests) (Boyd et al., 2006; Sasson et al., 2012). Future research should investigate the possibility of differential obsessional and attentional levels between and among certain objects of interest (or obsession content) for AS children.

Predicted results also mentioned that there was no predicted difference between and among the recognition of the four emotions tested. This prediction was based on an absence of findings in this area, in prior literature. Still, there is a possibility that this might not be the case. Future research should observe whether or not children with AS recognize these emotions to different and separate degrees.

The newly altered version of the CAM-C was novel to this study. The cut-off score and expected mean were also novel. The design of this study rendered the alteration of the CAM-C necessary, in order to properly test the emotions taught throughout the intervention viewing period. This new version has not been tested for test-retest reliability, parallel forms reliability, or internal consistency reliability. Future research should test for reliability and collect a multitude of data in order to generate a well backed cutoff score. In addition, perhaps more emotions from the original CAM-C could be incorporated into the intervention and included in the altered CAM-C. This would bolster the range of emotions taught, as well as tested.

The parental questionnaire that was created for this study was entirely new, which was necessary due to the intricate design of this study. It had no prior literature backing it's efficacy, reliability, nor cutoff score. Items and sections of this parental questionnaire were borrowed from previously tested measures of obsession and ASD related traits (Baron-Cohen & Wheelwright, 1999; Russell, 2005; Goodman et al., 1989; Scahill et al., 1997; Scahill et al., 2014; Storch et al., 2006). Future research should test whether or not this parental questionnaire accurately captures the participant's obsessions and obsessional qualities, behaviors, and characteristics. Investigations and reliability and a proper cutoff score should also be completed in future studies.

The design of this study called for participants to complete the CAM-C before the intervention viewing period, as well as after the intervention viewing period. The repetition of this test, although spanned at the start and finish of the four month time period, could have had some test bias effects. There is a possibility that participants might have demonstrated response bias, test re-test effects, and/or testing effects. Due to the longitudinal design of this study,

fatigue could have effected their participation and test performances as well. Future research should consider these possible effects and biases in the interpretation of their results and findings.

This study only utilized male participants due to prior findings of higher rates of autism in males (Croen, Grether, & Selvin, 2002). There might have possibly been an effect of gender in the results for this study. Future research should investigate whether or not these results are also replicable in female subjects.

This study borrowed from Golan et al., (2009) with regards to parental involvement during intervention viewing periods. This parental involvement was encouraged due to it's implementation in prior research (Golan at al., 2009). It was also encouraged as a means of aiding the child in their understanding and interpretation of the intervention. While it was detailed to the parents, the exact amount of parental involvement was not recorded, as the intervention viewing took place at home. The amount of parental involvement could have influenced how much attention was paid to the intervention, and possibly how much the participants understood and internalized the intervention episodes. Future research should create a parental participation log for parents to fill out, in order to incorporate their involvement into interpretation of the final results.

The eye tracking device used in this study costs upwards of $11,000. The software is an additional $8,000. It was also suggested that each participant takes home the eye tracker and its software, and use it while they view the intervention episodes. This would be very costly. There is also the risk of the parent or participant damaging the technology or software, or not

using them properly. Future research should utilize less expensive eye-tracking technology, and perhaps give a tutorial to the parents and participants on how to set it up at home.

Due to budgeting restrictions, the episodes of the original *The Transporters* were not obtained. The episodes needed for this study taught the emotions of *unfriendly, jealous, joking,* and *ashamed.* As mentioned before in the section entitled "Exact Alterations to *The Transporters* and the CAM-C", the episodes that relayed the emotions of *joking* and *ashamed* were to be altered to relay the emotions of *amused* and *bothered*. Therefore, there is no original script to be modified to feature these two emotions. Future research should obtain the original *The Transporters*, and make record of the newly altered script.

Lastly, the crucial aspect of this design is the highly specialized and individualized nature of the intervention, for the individual. Making new versions of *The Transporters* that feature the wide variety of content that AS individuals are obsessed with would be both time consuming and tedious. This could be considered a possible limitation. That being said, this aspect is completely necessary for the design and efficacy of this study and future studies in this subject area.

Works Cited

Allison, C., Williams, J., Scott, F., Stott, C., Bolton, P., Baron-Cohen, S., & Brayne, C. (2007). The Childhood Asperger Syndrome Test (CAST): Test-retest reliability in a high scoring sample. *Autism*, *11*(2), 173-185. http://dx.doi.org/10.1177/1362361307075710

American Psychiatric Association. (2013). *Diagnostic and Statistical Manual of Mental Disorders - DSM-V* (5th ed.). Washington, D.C.: American Psychiatric Association, Washington, D.C.

ARC Tests. (2017). *Autismresearchcentre.com*. Retrieved 23 April 2017, from https://www.autismresearchcentre.com/arc_tests/

Autism Research Center at Cambridge University. (2017). *Vehicles/Animated Faces in The Transporters Intervention*. Retrieved from http://www.thetransporters.com/about.html

Auyeung, B., Baron-Cohen, S., Wheelwright, S., & Allison, C. (2007). The Autism Spectrum Quotient: Children's Version (AQ-Child). *Journal Of Autism And Developmental Disorders*, *38*(7), 1230-1240. http://dx.doi.org/10.1007/s10803-007-0504-z

Baker, M., Koegel, R., & Koegel, L. (1998). Increasing the Social Behavior of Young Children With Autism Using Their Obsessive Behaviors. *Research And Practice For Persons With Severe Disabilities*, *23*(4), 300-308. http://dx.doi.org/10.2511/rpsd.23.4.300

Baron-Cohen, S. (1992). Out of Sight or Out of Mind? Another Look at Deception in Autism. *Journal Of Child Psychology And Psychiatry*, *33*(7), 1141-1155. http://dx.doi.org/10.1111/j.1469-7610.1992.tb00934.x

Baron-Cohen, S. (1997). Are children with autism superior at folk physics?. *New Directions For Child And Adolescent Development*, *1997*(75), 45-54. http://dx.doi.org/10.1002/cd.23219977504

Baron-Cohen, S. (1997). *Mindblindness* (1st ed., pp. 51, 69). Cambridge, Mass.: MIT Press.

Baron-Cohen, S. (2006). The hyper-systemizing, assortative mating theory of autism. *Progress In Neuro-Psychopharmacology And Biological Psychiatry*, *30*(5), 865-872. http://dx.doi.org/10.1016/j.pnpbp.2006.01.010

Baron-Cohen, S., & Wheelwright, S. (1999). 'Obsessions' in children with autism or Asperger syndrome. Content analysis in terms of core domains of cognition. *The British Journal Of Psychiatry*, *175*(5), 484-490. http://dx.doi.org/10.1192/bjp.175.5.484

Baron-Cohen, S., & Wheelwright, S. (1999). 'Obsessions' in children with autism or Asperger syndrome. Content analysis in terms of core domains of cognition. *The British Journal Of Psychiatry*, *175*(5), 484-490. http://dx.doi.org/10.1192/bjp.175.5.484

Baron-Cohen, S., Ashwin, E., Ashwin, C., Tavassoli, T., & Chakrabarti, B. (2009). Talent in autism: hyper-systemizing, hyper-attention to detail and sensory hypersensitivity. *Philosophical Transactions Of The Royal Society B: Biological Sciences*, *364*(1522), 1377-1383. http://dx.doi.org/10.1098/rstb.2008.0337

Baron-Cohen, S., Golan, O., & Ashwin, E. (2017). Can emotion recognition be taught to children with autism spectrum?. *Philos Trans R Soc Lond B Biol Sc*, *364*(1535). http://dx.doi.org/10.1098/rstb.2009.0191

Baron-Cohen, S., Wheelwright, S., Skinner, R., Martin, J., & Clubly, E. (2017). The Autism-Spectrum Quotient (AQ): Evidence from Asperger Syndrome/High-Functioning Autism, Malesand Females, Scientists and Mathematicians. *Journal Of Autism And Developmental Disorders*, *31*(1). Retrieved from http://docs.autismresearchcentre.com/papers/2001_BCetal_AQ.pdf

Bauminger-Zviely, N. (2013). False-Belief Task. *Encyclopedia Of Autism Spectrum Disorders*. Retrieved from http://link.springer.com/referenceworkentry/10.1007%2F978-1-4419-1698-3_91

Bjorklund, D., & Ellis, B. (2005). Origins of the social mind: evolutionary psychology and child development. *Choice Reviews Online*, *43*(01), 43-0633-43-0633. http://dx.doi.org/10.5860/choice.43-0633

Boyd, B., Conroy, M., Mancil, G., Nakao, T., & Alter, P. (2006). Effects of Circumscribed Interests on the Social Behaviors of Children with Autism Spectrum Disorders. *Journal Of Autism And Developmental Disorders*, *37*(8), 1550-1561. http://dx.doi.org/10.1007/s10803-006-0286-8

Castelhano, M., Mack, M., & Henderson, J. (2009). Viewing task influences eye movement control during active scene perception. *Journal Of Vision*, *9*(3), 6-6. http://dx.doi.org/10.1167/9.3.6

Consent Form Templates and Examples | Social & Behavioral Sciences Institutional Review Board | The University of Chicago. (2017). *Sbsirb.uchicago.edu*. Retrieved 17 April 2017, from https://sbsirb.uchicago.edu/page/consent-form-templates-and-examples

Croen, L., Grether, J., & Selvin, S. (2002). Descriptive Epidemiology of Autism in a California Population: Who Is at Risk?. *Journal Of Autism And Developmental Disorders*, *32*(3). http://dx.doi.org/10.1023/A:1015405914950

d'Ydewalle, G., & Gielen, I. Attention Allocation with Overlapping Sound, Image, and Text. *Springer Series In Neuropsychology*, 415-427. Retrieved from http://link.springer.com/chapter/10.1007%2F978-1-4612-2852-3_25

Deruelle, C., Rondan, C., Gepner, B., & Tardif, C. (2004). Spatial Frequency and Face Processing in Children with Autism and Asperger Syndrome. *Journal Of Autism And Developmental Disorders*, *34*(2), 199-210. http://dx.doi.org/10.1023/b:jadd.0000022610.09668.4c

Duchaine, B., & Nakayama, K. (2006). The Cambridge Face Memory Test: Results for neurologically intact individuals and an investigation of its validity using inverted face stimuli and prosopagnosic participants. *Neuropsychologia*, *44*(4), 576-585. http://dx.doi.org/10.1016/j.neuropsychologia.2005.07.001

Ellis, B., & Bjorklund, D. (2004). *Origins of the Social Mind Evolutionary Psychology and Child Development* (1st ed., pp. 383-385).

Frith, C., & Frith, U. (2005). Theory of mind. *Current Biology*, *15*(17), R644-R645. http://dx.doi.org/10.1016/j.cub.2005.08.041

Frith, U. (2001). Mind Blindness and the Brain in Autism. *Neuron*, *32*(6), 969-979. http://dx.doi.org/10.1016/s0896-6273(01)00552-9

Golan, O., Ashwin, E., Granader, Y., McClintock, S., Day, K., Leggett, V., & Baron-Cohen, S. (2009). Enhancing Emotion Recognition in Children with Autism Spectrum Conditions: An Intervention Using Animated Vehicles with Real Emotional Faces. *Journal Of Autism And Developmental Disorders*, *40*(3), 269-279. http://dx.doi.org/10.1007/s10803-009-0862-9

Golan, O., Baron-Cohen, S., & Hill, J. (2006). The Cambridge Mindreading (CAM) Face-Voice Battery: Testing Complex Emotion Recognition in Adults with and without Asperger Syndrome. *Journal Of Autism And Developmental Disorders*, *36*(2), 169-183. http://dx.doi.org/10.1007/s10803-005-0057-y

Golan, O., Sinai-Gavrilov, Y., & Baron-Cohen, S. (2015). The Cambridge Mindreading Face-Voice Battery for Children (CAM-C): complex emotion recognition in children with and without autism spectrum conditions. *Molecular Autism*, *6*(1). http://dx.doi.org/10.1186/s13229-015-0018-z

Goodman, W., Price, L., Rasmussen, S., Mazure, C., Fleischmann, R., & Hill, C. et al. (1989). The Yale-Brown Obsessive Compulsive Scale - Development, use, and reliability., *46*(1006). Retrieved from http://www.brainphysics.com/research/ybocs_goodman89a.pdf

Goodman, W., Scahill, L., Price, L., Rasmussen, S., Riddle, M., & Rapoport, J. (2007). *Children's Yale-Brown Obsessive Compulsive Scale (CY-BOCS)*. *www.iocdf.org*. Retrieved 17 April 2017, from https://iocdf.org/wp-content/uploads/2016/04/05-CYBOCS-complete.pdf

Hall, G., Szechtman, H., & Nahmias, C. (2003). Enhanced salience and emotion recognition in Autism: a PET study. *Am J Psychiatry*, *160*(6). http://dx.doi.org/10.1176/appi.ajp.160.8.1439

Happé, F., & Frith, U. (2006). The Weak Coherence Account: Detail-focused Cognitive Style in Autism Spectrum Disorders. *Journal Of Autism And Developmental Disorders*, *36*(1), 5-25. http://dx.doi.org/10.1007/s10803-005-0039-0

Hedley, D., Brewer, N., & Young, R. (2011). Face recognition performance of individuals with Asperger syndrome on the Cambridge face memory test. *Autism Research*, *4*(6), 449-455. http://dx.doi.org/10.1002/aur.214

Hill, E. (2004). Executive Dysfunction in Autism. *TRENDS In Cognitive Sciences*, *8*(1). Retrieved from http://research.gold.ac.uk/2558/1/Hill_2004_GRO.pdf

Katagiri, M., Kasai, T., Kamio, Y., & Murohashi, H. (2012). Individuals with Asperger's Disorder Exhibit Difficulty in Switching Attention from a Local Level to a Global Level. *Journal Of Autism And Developmental Disorders*, *43*(2), 395-403. http://dx.doi.org/10.1007/s10803-012-1578-9

Kikuchi, Y., Senju, A., Tojo, Y., Osanai, H., & Hasegawa, T. (2009). Faces Do Not Capture Special Attention in Children With Autism Spectrum Disorder: A Change Blindness Study. *Child Development*, *80*(5), 1421-1433. http://dx.doi.org/10.1111/j.1467-8624.2009.01342.x

Klin, A., Volkmar, F., & Sparrow, S. (2000). *Asperger syndrome* (1st ed., pp. 125-131, 340-347). Philadelphia: Saunders.

Leung, D., Ordqvist, A., Falkmer, T., Parsons, R., & Falkmer, M. (2013). Facial emotion recognition and visual search strategies of children with high functioning autism and Asperger syndrome. *Research In Autism Spectrum Disorders*, *7*(7), 833-844. http://dx.doi.org/10.1016/j.rasd.2013.03.009

Leung, D., Ordqvist, A., Falkmer, T., Parsons, R., & Falkmer, M. (2013). Facial emotion recognition and visual search strategies of children with high functioning autism and Asperger syndrome. *Research In Autism Spectrum Disorders*, *7*(7), 833-844. http://dx.doi.org/10.1016/j.rasd.2013.03.009

Li, A., Kelley, E., Evans, A., & Lee, K. (2010). Exploring the Ability to Deceive in Children with Autism Spectrum Disorders. *Journal Of Autism And Developmental Disorders*, *41*(2), 185-195. http://dx.doi.org/10.1007/s10803-010-1045-4

McKenzie, K. (2004). Autism: explaining the enigma Uta Frith Second Autism: explaining the enigma Blackwell 264 £15.99 0631229019 0631229019. *Learning Disability Practice*, *7*(6), 28-28. http://dx.doi.org/10.7748/ldp.7.6.28.s20

McPartland, J., Webb, S., Keehn, B., & Dawson, G. (2010). Patterns of Visual Attention to Faces and Objects in Autism Spectrum Disorder. *Journal Of Autism And Developmental Disorders*, *41*(2), 148-157. http://dx.doi.org/10.1007/s10803-010-1033-8

Nader, A., Jelenic, P., & Soulières, I. (2015). Discrepancy between WISC-III and WISC-IV Cognitive Profile in Autism Spectrum: What Does It Reveal about Autistic Cognition?. *PLOS ONE*, *10*(12), e0144645. http://dx.doi.org/10.1371/journal.pone.0144645

Oswald, D., & Ollendick, T. (1989). Role taking and social competence in autism and mental retardation. *Journal Of Autism And Developmental Disorders*, *19*(1), 119-127. http://dx.doi.org/10.1007/bf02212723

Pannasch, S., Schulz, J., & Velichkovsky, B. (2011). On the control of visual fixation durations in free viewing of complex images. *Attention, Perception, & Psychophysics*, *73*(4), 1120-1132. http://dx.doi.org/10.3758/s13414-011-0090-1

Perner, J., Frith, U., Leslie, A., & Leekam, S. (1989). Exploration of the Autistic Child's Theory of Mind: Knowledge, Belief, and Communication. *Child Development*, *60*(3), 689. http://dx.doi.org/10.2307/1130734

Prior, M. (2005). *Learning and behavior problems in Asperger syndrome* (1st ed., pp. 126-132). New York: Guilford Press.

Rayner, K. (1998). Eye Movements in Reading and Information Processing: 20 Years of Research, *124*(3). Retrieved from https://www.ncbi.nlm.nih.gov/pubmed/9849112

Ribeiro, L., & Fearon, N, P. (2010). Theory of mind and attentional bias to facial emotional expressions: A preliminary study. *Scandinavian Journal Of Psychology*. http://dx.doi.org/10.1111/j.1467-9450.2009.00797.x

Riby, D., & Hancock, P. (2008). Do Faces Capture the Attention of Individuals with Williams Syndrome or Autism? Evidence from Tracking Eye Movements. *Journal Of Autism And Developmental Disorders*, *39*(3), 421-431. http://dx.doi.org/10.1007/s10803-008-0641-z

Rump, K., Giovannelli, J., Minshew, N., & Strauss, M. (2009). The Development of Emotion Recognition in Individuals With Autism. *Child Development*, *80*(5), 1434-1447. http://dx.doi.org/10.1111/j.1467-8624.2009.01343.x

Russel, A. (2005). Obsessions and compulsions in Asperger syndrome and high-functioning autism. *The British Journal Of Psychiatry*, *186*(6), 525-528. http://dx.doi.org/10.1192/bjp.186.6.525

Ruta, L., Mugno, D., D'Arrigo, V., Vitiello, B., & Mazzone, L. (2009). Obsessive–compulsive traits in children and adolescents with Asperger syndrome. *European Child & Adolescent Psychiatry*, *19*(1), 17-24. http://dx.doi.org/10.1007/s00787-009-0035-6

Sample Consent/Assent and Debriefing Forms. (2017). *Davidson.edu*. Retrieved 17 April 2017, from https://www.davidson.edu/offices/grants-and-contracts/human-subjects-irb/hsirb-policies-and-procedures/informed-consent/sample-consent-and-debriefing-forms

Sasson, N., Dichter, G., & Bodfish, J. (2012). Affective Responses by Adults with Autism Are Reduced to Social Images but Elevated to Images Related to Circumscribed Interests. *Plos ONE*, *7*(8), e42457. http://dx.doi.org/10.1371/journal.pone.0042457

Sasson, N., Turner-Brown, L., Holtzclaw, T., Lam, K., & Bodfish, J. (2008). Children with autism demonstrate circumscribed attention during passive viewing of complex social and nonsocial picture arrays. *Autism Research*, *1*(1), 31-42. http://dx.doi.org/10.1002/aur.4

Scahill, L., Dimitropoulos, A., McDougle, C., Aman, M., Feurer, I., & McCracken, J. et al. (2014). Children's Yale–Brown Obsessive Compulsive Scale in Autism Spectrum Disorder: Component Structure and Correlates of Symptom Checklist. *Journal Of The American Academy Of Child & Adolescent Psychiatry*, *53*(1), 97-107.e1. http://dx.doi.org/10.1016/j.jaac.2013.09.018

Scahill, L., Riddle, M., McSwiggin-Hardin, M., Ort, S., King, R., & Goodman, W. et al. (1997). Children's Yale-Brown Obsessive Compulsive Scale: Reliability and Validity. *J Am Acad Child Adolesc Psychiatry*, *36*(6). Retrieved from https://www.ncbi.nlm.nih.gov/pubmed/9183141

Scott, F., Baron-Cohen, S., Bolton, P., & Brayne, C. (2002). The CAST (Childhood Asperger Syndrome Test): Preliminary Development of a UK Screen for Mainstream Primary-School-Age Children. *Autism*, *6*(1), 9-31. http://dx.doi.org/10.1177/1362361302006001003

Storch, E., Murphy, T., Adkins, J., Lewin, A., Geffken, G., & Johns, N. et al. (2006). The children's Yale-Brown obsessive–compulsive scale: Psychometric properties of child- and

parent-report formats. *Journal Of Anxiety Disorders*, *20*(8), 1055-1070. http://dx.doi.org/10.1016/j.janxdis.2006.01.006

Sullivan, M., & Lewis, M. (2003). Emotional Expressions of Young Infants and Children. *Infants & Young Children*, *16*(2), 120-142. http://dx.doi.org/10.1097/00001163-200304000-00005

Tager-Flusberg, H. (1992). Autistic Children's Talk about Psychological States: Deficits in the Early Acquisition of a Theory of Mind. *Child Development*, *63*(1), 161. http://dx.doi.org/10.2307/1130910

Taylor, J., & Seltzer, M. (2010). Changes in the Autism Behavioral Phenotype During the Transition to Adulthood. *Journal Of Autism And Developmental Disorders*, *40*(12). Retrieved from http://link.springer.com/article/10.1007/s10803-010-1005-z

Tobii Pro X2-60 screen-based eye tracker. (2017). *Tobiipro.com*. Retrieved 16 April 2017, from http://www.tobiipro.com/product-listing/tobii-pro-x2-60/

Wechsler Intelligence Scale For Children - Fourth Edition - Descriptive and Graphical Report. *Psychoeducational Solutions Of Tampa Bay*. Retrieved from http://www.child-testing.com/images/pdfs/gifted-testing-sample-report.pdf

Wechsler, D. (1949). Wechsler Intelligence Scale for Children. Retrieved from http://psycnet.apa.org/psycinfo/1950-02930-000

Williams, J., Allison, C., Scott, F., Stott, C., & Bolton, P. (2006). The Childhood Asperger Syndrome Test (CAST) Test–retest reliability. Retrieved from http://journals.sagepub.com/doi/abs/10.1177/1362361306066612

Williams, J., Allison, C., Scott, F., Stott, C., Bolton, P., Baron-Cohen, S., & Brayne, C. (2006). The Childhood Asperger Syndrome Test (CAST) - Test Accuracy. *Autism*, *10*(4), 415-427. http://dx.doi.org/10.1177/1362361306066612

Williams, J., Scott, F., Stott, C., Allison, C., Bolton, P., Baron-Cohen, S., & Brayne, C. (2005). The CAST (Childhood Asperger Syndrome Test). *Autism*, *9*(1), 45-68. http://dx.doi.org/10.1177/1362361305049029

Yi, L., Fan, Y., Li, J., Huang, D., Wang, X., & Tan, W. et al. (2014). Distrust and retaliatory deception in children with Autism Spectrum Disorder. *Research In Autism Spectrum Disorders*, *8*(12), 1741-1755. http://dx.doi.org/10.1016/j.rasd.2014.09.006

Young, R., & Posselt, M. (2011). Using The Transporters DVD as a Learning Tool for Children with Autism Spectrum Disorders (ASD). *Journal Of Autism And Developmental Disorders*, *42*(6), 984-991. http://dx.doi.org/10.1007/s10803-011-1328-4

Appendix A

Table 1.
Layout of groups and assigned conditions.

Original Groups:

AS1 (n.40) - obsessed with trains
AS2 (n.40) - obsessed with clocks

Subgroups	**Conditions**
AS1A (n.20) - obsessed with trains	**OBS**
AS1B (n.20) - obsessed with trains	**N-OBS**
AS2A (n.20) - obsessed with clocks	**OBS**
AS2B (n.20) - obsessed with clocks	**N-OBS**

Appendix B

The Autism Spectrum Quotient—Children's Version (AQ-Child)

NOTE: This questionnaire is to be completed by the parent/guardian of each child aged 4 and above. Please complete all three pages.

Name ……
Date of Birth (Month in words) …… Today's date (Month in words)…….
Address…….

Please answer each of the following questions about your child or the person who is under your care by ticking a box that reflects your answer to the question most appropriately. If there is any question that you feel not able to comment, please ask your son, daughter, partner or the person to answer.

	Definitely Agree	Slightly Agree	Slightly Disagree	Definitely Disagree
1. S/he prefers to do things with others rather than on her/his own.				
2. S/he prefers to do things the same way over and over again.				
3. If s/he tries to imagine something, s/he finds it very easy to create a picture in her/his mind.				
4. S/he frequently gets so strongly absorbed in one thing that s/he loses sight of other things.				
5. S/he often notices small sounds when others do not.				
6. S/he usually notices house numbers or similar strings of information.				
7. S/he has difficulty understanding rules for polite behaviour.				
8. When s/he is read a story, s/he can easily imagine what the characters might look like.				
9. S/he is fascinated by dates.				
10. In a social group, s/he can easily keep track of several different people's conversations.				
11. S/he finds social situations easy.				
12. S/he tends to notice details that others do not.				

13. S/he would rather go to a library than a birthday party.				
	Definitely Agree	**Slightly Agree**	**Slightly Disagree**	**Definitely Disagree**
14. S/he finds making up stories easy.				
15. S/he is drawn more strongly to people than to things.				
16. S/he tends to have very strong interests, which s/he gets upset about if s/he can't pursue.				
17. S/he enjoys social chit-chat.				
18. When s/he talks, it isn't always easy for others to get a word in edgeways.				
19. S/he is fascinated by numbers.				
20. When s/he is read a story, s/he finds it difficult to work out the characters' intentions or feelings.				
21. S/he doesn't particularly enjoy fictional stories.				
22. S/he finds it hard to make new friends.				
23. S/he notices patterns in things all the time.				
24. S/he would rather go to the cinema than a museum.				
25. It does not upset him/her if his/her daily routine is disturbed.				
26. S/he doesn't know how to keep a conversation going with her/his peers.				
27. S/he finds it easy to "read between the lines" when someone is talking to her/him.				
28. S/he usually concentrates more on the whole picture, rather than the small details.				
29. S/he is not very good at remembering phone numbers.				
30. S/he doesn't usually notice small changes in a situation, or a person's appearance.				
31. S/he knows how to tell if someone listening to him/her is getting bored.				
32. S/he finds it easy to go back and forth between different activities.				
33. When s/he talk on the phone, s/he is not sure when it's her/his turn to speak.				

	Definitely Agree	**Slightly Agree**	**Slightly Disagree**	**Definitely Disagree**
34. S/he enjoys doing things spontaneously.				
35. S/he is often the last to understand the point of a joke.				
36. S/he finds it easy to work out what someone is thinking or feeling just by looking at their face.				
37. If there is an interruption, s/he can switch back to what s/he was doing very quickly.				
38. S/he is good at social chit-chat.				
39. People often tell her/him that s/he keeps going on and on about the same thing.				
40. When s/he was in preschool, s/he used to enjoy playing games involving pretending with other children.				
41. S/he likes to collect information about categories of things (e.g. types of car, types of bird, types of train, types of plant, etc.).				
42. S/he finds it difficult to imagine what it would be like to be someone else.				
43. S/he likes to plan any activities s/he participates in carefully.				
44. S/he enjoys social occasions.				
45. S/he finds it difficult to work out people's intentions.				
46. New situations make him/her anxious.				
47. S/he enjoys meeting new people.				
48. S/he is good at taking care not to hurt other people's feelings.				
49. S/he is not very good at remembering people's date of birth.				
50. .S/he finds it very to easy to play games with children that involve pretending.				

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Appendix C

The Childhood Asperger Syndrome Test (CAST)

Child's Name: ..... Age: ..... Sex: Male / Female
Birth Order: ..... Twin or Single Birth: .....
Parent/Guardian: .....
Parent(s) occupation: .....
Age parent(s) left full-time education: .....
Address: .....
.....
.....
Tel.No: ..... School: .....

Please read the following questions carefully, and circle the appropriate answer. All responses are confidential.

1. Does s/he join in playing games with other children easily?	Yes	No	
2. Does s/he come up to you spontaneously for a chat?	Yes	No	
3. Was s/he speaking by 2 years old?		Yes	No
4. Does s/he enjoy sports?	Yes	No	
5. Is it important to him/her to fit in with the peer group?	Yes	No	
6. Does s/he appear to notice unusual details that others miss?	Yes	No	
7. Does s/he tend to take things literally?	Yes	No	
8. When s/he was 3 years old, did s/he spend a lot of time pretending (e.g., play-acting being a superhero, or holding teddy's tea parties)?	Yes	No	
9. Does s/he like to do things over and over again, in the same way all the time?	Yes	No	
10. Does s/he find it easy to interact with other			

children?	Yes	No
11. Can s/he keep a two-way conversation going?	Yes	No
12. Can s/he read appropriately for his/her age?	Yes	No
13. Does s/he mostly have the same interests as his/her peers?	Yes	No
14. Does s/he have an interest which takes up so much time that s/he does little else?	Yes	No
15. Does s/he have friends, rather than just acquaintances?	Yes	No
16. Does s/he often bring you things s/he is interested in to show you?	Yes	No
17. Does s/he enjoy joking around?	Yes	No
18. Does s/he have difficulty understanding the rules for polite behaviour?	Yes	No
19. Does s/he appear to have an unusual memory for Details?	Yes	No
20. Is his/her voice unusual (e.g., overly adult, flat, or very monotonous)?	Yes	No
21. Are people important to him/her?	Yes	No
22. Can s/he dress him/herself?	Yes	No
23. Is s/he good at turn-taking in conversation?	Yes	No
24. Does s/he play imaginatively with other children, and engage in role-play?	Yes	No
25. Does s/he often do or say things that are tactless or socially inappropriate?	Yes	No
26. Can s/he count to 50 without leaving out any numbers?	Yes	No
27. Does s/he make normal eye-contact?	Yes	No
28. Does s/he have any unusual and repetitive		

movements? Yes No

29. Is his/her social behaviour very one-sided and always on his/her own terms? Yes No

30. Does s/he sometimes say "you" or "s/he" when s/he means "I"? Yes No

31. Does s/he prefer imaginative activities such as play-acting or story-telling, rather than numbers or lists of facts? Yes No

32. Does s/he sometimes lose the listener because of not explaining what s/he is talking about? Yes No

33. Can s/he ride a bicycle (even if with stabilisers)? Yes No

34. Does s/he try to impose routines on him/herself, or on others, in such a way that it causes problems? Yes No

35. Does s/he care how s/he is perceived by the rest of the group? Yes No

36. Does s/he often turn conversations to his/her favourite subject rather than following what the other person wants to talk about? Yes No

37. Does s/he have odd or unusual phrases? Yes No

SPECIAL NEEDS SECTION
Please complete as appropriate

38. Have teachers/health visitors ever expressed any

concerns about his/her development? Yes No

If Yes, please specify.....

39. Has s/he ever been diagnosed with any of the following?:

Language delay Yes No

Hyperactivity/Attention Deficit Disorder (ADHD) Yes No

Hearing or visual difficulties	Yes	No
Autism Spectrum Condition, incl. Asperger's Syndrome	Yes	No
A physical disability	Yes	No
Other (please specify)	Yes	No

Appendix D

Parental Questionnaire - Parent

Participant's name _____
Parent's name _____

Please define "obsession(s):

_____
_____

Listen to clinician's definition of obsession(s).

TARGET SYMPTOM LIST FOR OBSESSIONS
Obsessions (Describe, listing by order of severity, with #1 being the most severe, #2 the second most severe, etc.):

1._____

2._____

3._____

4._____

QUESTIONS ON OBSESSIONS (ITEMS 1-6)

Rate the characteristics of each item over the prior week up until, and including, the time of the interview. Scores should reflect the average of each item for the entire week, unless otherwise specified.

1. Time Occupied by Obsessive Thoughts

• How much time does your child spend thinking about these things?
(When obsessions occur as brief, intermittent intrusions, it may be impossible to assess time occupied by them in terms of total hours. In such cases, estimate time by determining how frequently they occur. Consider both the number of times the intrusions occur and how many hours of the day are affected).
• How frequently do these thoughts occur for your child?
[Exclude ruminations and preoccupations which, unlike obsessions, are ego-syntonic and rational (but exaggerated).]
0 - NONE
1 - MILD less than 1 hr/day or occasional intrusion
2 - MODERATE 1 to 3 hrs/day or frequent intrusion

3 - SEVERE greater than 3 and up to 8 hrs/day or very frequent intrusion
4 - EXTREME greater than 8 hrs/day or near constant intrusion

2. Obsession-free Interval

- On average, what is the longest amount of time per day that your child is not bothered by obsessive thoughts?

0 - NONE
1 - MILD long symptom free intervals, more than 8 consecutive hrs/day symptom-free
2 - MODERATE moderately long symptom-free intervals, more than 3 and up to 8 hrs/day
3 - SEVERE brief symptom-free intervals, from 1 to 3 consecutive hrs/day symptom-free
4 - EXTREME less than 1 consecutive hr/day symptom free

3. Interference due to Obsessive Thoughts

• How much do these thoughts get in the way of school or doing things with friends, for your child?
• Is there anything that your child doesn't do because of them?
(If currently not in school determine how much performance would be affected if patient were in school.)

0 - NONE
1 - MILD slight interference with social or school activities, overall performance not impaired
2 - MODERATE definite interference with social or school performance, but still manageable
3 - SEVERE causes substantial impairment in social or school performance
4 - EXTREME incapacitating

4. Distress Associated with Obsesssive Thoughts

• How much do these thoughts bother or upset your child?
(Only rate anxiety/frustration that seems triggered by obsessions, not generalized anxiety or anxiety associated with other symptoms.)

0 - NONE
1 - MILD infrequent, and not too disturbing
2 - MODERATE frequent, and disturbing, but still manageable
3 - SEVERE very frequent, and very disturbing
4 - EXTREME near constant, and disabling distress/frustration

5. Resistance Against Obsessions

• How hard does your child try to stop the thoughts or ignore them?
(Only rate effort made to resist, not success or failure in actually controlling the obsessions. How much your child resists the obsessions may or may not correlate with their ability to control them. Note that this item does not directly measure the severity of the intrusive thoughts; rather it rates a manifestation of health, i.e., the effort the patient makes to counteract the obsessions. Thus, the more your child tries to resist, the less impaired is this aspect of his functioning. If the obsessions are minimal, your child may not feel the need to resist them. In such cases, a rating of "0" should be given.)

0 – NONE makes an effort to always resist, or symptoms so minimal doesn't need to actively resist.

1 - MILD tries to resist most of the time
2 - MODERATE makes some effort to resist
3 - SEVERE yields to all obsessions without attempting to control them, but does so with some reluctance
4 – EXTREME completely and willingly yields to all obsessions

6. Degree of Control Over Obsessive Thoughts

• When your child ties to fight the thoughts, can your child beat them?

• How much control do your child have over the thoughts?
(In contrast to the preceding item on resistance, the ability of your child to control his obsessions is more closely related to the severity of the intrusive thoughts.)

0 - COMPLETE CONTROL
1 - MUCH CONTROL usually able to stop or divert obsessions with some effort and concentration.
2 - MODERATE CONTROL sometimes able to stop or divert obsessions
3 - LITTLE CONTROL rarely successful in stopping obsessions, can only divert attention with difficulty
4 - NO CONTROL experienced as completely involuntary, rarely able to even momentarily divert thinking

CS-PR (Altered, items 7-11)

Rate the characteristics of each item over the prior week up until, and including, the time of the interview. Scores should reflect the average of each item for the entire week, unless otherwise specified. Here, your child will be asked to leave the room.

Severity Scale For Obsessions:

7. Interference:

- To what degree does your child's obsession interfere with everyday functioning? Areas such as: social, familial, and school-related.

0 - NONE
1 - MILD slight interference with social or school activities, overall performance not impaired
2 - MODERATE definite interference with social or school performance, but still manageable
3 - SEVERE causes substantial impairment in social or school performance
4 - EXTREME incapacitating

8. Distress:

- To what degree does your child's obsession seem to physically/emotionally distress them?

0 - NONE
1 - MILD infrequent, and not too disturbing
2 - MODERATE frequent, and disturbing, but still manageable
3 - SEVERE very frequent, and very disturbing
4 - EXTREME near constant, and disabling distress/frustration

9. Frequency:

- On average, how frequently does your child exhibit obsessional behaviors towards their object of interest?

0 - NONE
1 - MILD infrequent, and not too disturbing
2 - MODERATE frequent, and disturbing, but still manageable
3 - SEVERE very frequent, and very disturbing
4 - EXTREME near constant, and disabling distress/frustration

10. Disturbance Scale For Obsessions:

Resistance:

- How hard does your child try to resist obsessive thoughts towards their object of obsession?

(If the obsessions are minimal, the patient may not feel the need to resist them. In such cases, a rating of "0" should be given.)
0 – NONE makes an effort to always resist, or symptoms so minimal doesn't need to actively resist.
1 - MILD tries to resist most of the time
2 - MODERATE makes some effort to resist

3 - SEVERE yields to all obsessions without attempting to control them, but does so with some reluctance
4 – EXTREME completely and willingly yields to all obsessions

11. <u>Control</u>:

- How often does your child try to assert control over the obsessional thoughts they hold towards their object of obsession? How much control over these obsessional thoughts do you believe they possess?

0 - COMPLETE CONTROL
1 - MUCH CONTROL usually able to stop or divert obsessions with some effort and concentration.
2 - MODERATE CONTROL sometimes able to stop or divert obsessions
3 - LITTLE CONTROL rarely successful in stopping obsessions, can only divert attention with difficulty
4 - NO CONTROL experienced as completely involuntary, rarely able to even momentarily divert thinking

_____

—

<u>CAMBRIDGE UNIVERSITY OBSESSIONS QUESTIONNAIRE (altered) Items 11-15</u>

For each category of obsession, please tick whether your child has ever had an obsession in that category. If "YES", please specify the exact obsession(s).

11. <u>MACHINES</u> (how things work) e.g. computers, radios, TVs, washing machines, clocks, burglar alarms, etc.,
YES NO
If YES, please specify

_____
_____

12. <u>SYSTEMS</u> e.g. toilet flushing, drains, light switches, etc.,
YES NO
If YES, please specify

_____
_____

13. <u>STRONGLY ATTACHED TO A PARTICULAR ITEM</u> e.g. an article of clothing, a rag, a bottle top, etc.,
YES NO
If YES, please specify

_____
_____

14. <u>FACTUAL INFORMATION</u> e.g. writing, reading or memorising lists of things, writing letters, reading encyclopaedias, newspapers, etc.,
YES NO
If YES, please specify

_____
_____

15. <u>OTHER</u>: Please list any other obsessions which you do not feel are covered by the other categories

_____

_____

_____

<u>EXACT CONTENT OF OBSESSION (Item 16)</u>

16. <u>Please mark off whether your child is obsessed with trains, clocks, or both.</u>

- 1. Trains _____
- 2. Clocks _____
- 3. Both Trains & Clocks _____
- 4. Neither Clocks nor Trains _____

Parental Questionnaire - Clinician

Participant's name _____
Parent's name _____

<u>1.</u> Define "Obsessions":

Before proceeding with the questions, define "obsessions" for the patient as follows:

"OBSESSIONS are unwelcome and distressing ideas, thoughts, images or impulses that repeatedly enter your mind. They may seem to occur against your will. They may be repugnant to you, you may recognize them as senseless, and they may not fit your personality."

"Let me give you some examples of obsessions"

"An example of an obsession is: the recurrent thought or impulse to do serious physical harm to your children even though you never would."

"Do you have any questions about what these words mean?" [If not, proceed.]

Define "obsession(s):

_____
_____

Child Response(s) If Present:

_____
_____

2. Ask parent to fill out Target Symptom List For Obsessions from CY-BOCS

"I am now going to ask you to list, in order of severity, the exact obsessions you believe your child possess. This can include their object of interest and/or the direct content of their obsession. It can also be thought as a listing of the objects, within order of severity, to which they devote the majority of their obsession-like qualities to."

TARGET SYMPTOM LIST FOR OBSESSIONS

Obsessions (Describe, listing by order of severity, with #1 being the most severe, #2 the second most severe, etc.):

1._____

2._____

3._____

4._____

Child Response(s) If Present:

_____

3. Ask parent to fill out **Questions on Obsessions (ITEMS 1-5) from CY-BOCS**

"I am now going to ask you questions about the thoughts your child cannot stop thinking about." (Review for the parent the Target Symptoms and refer to them while asking questions 1-5).

QUESTIONS ON OBSESSIONS (ITEMS 1-6)

Rate the characteristics of each item over the prior week up until, and including, the time of the interview. Scores should reflect the average of each item for the entire week, unless otherwise specified.

1. Time Occupied by Obsessive Thoughts

• How much time does your child spend thinking about these things?
(When obsessions occur as brief, intermittent intrusions, it may be impossible to assess time occupied by them in terms of total hours. In such cases, estimate time by determining how frequently they occur. Consider both the number of times the intrusions occur and how many hours of the day are affected).
• How frequently do these thoughts occur for your child?
[Exclude ruminations and preoccupations which, unlike obsessions, are ego-syntonic and rational (but exaggerated).]
0 - NONE
1 - MILD less than 1 hr/day or occasional intrusion
2 - MODERATE 1 to 3 hrs/day or frequent intrusion
3 - SEVERE greater than 3 and up to 8 hrs/day or very frequent intrusion
4 - EXTREME greater than 8 hrs/day or near constant intrusion

2. Obsession-free Interval

- On average, what is the longest amount of time per day that your child is not bothered by obsessive thoughts?

0 - NONE
1 - MILD long symptom free intervals, more than 8 consecutive hrs/day symptom-free
2 - MODERATE moderately long symptom-free intervals, more than 3 and up to 8 hrs/day
3 - SEVERE brief symptom-free intervals, from 1 to 3 consecutive hrs/day symptom-free
4 - EXTREME less than 1 consecutive hr/day symptom free

3. Interference due to Obsessive Thoughts
• How much do these thoughts get in the way of school or doing things with friends, for your child?
• Is there anything that your child doesn't do because of them?
(If currently not in school determine how much performance would be affected if patient were in school.)
0 - NONE
1 - MILD slight interference with social or school activities, overall performance not impaired
2 - MODERATE definite interference with social or school performance, but still manageable
3 - SEVERE causes substantial impairment in social or school performance
4 - EXTREME incapacitating

4. Distress Associated with Obsesssive Thoughts
• How much do these thoughts bother or upset your child?
(Only rate anxiety/frustration that seems triggered by obsessions, not generalized anxiety or anxiety associated with other symptoms.)
0 - NONE
1 - MILD infrequent, and not too disturbing
2 - MODERATE frequent, and disturbing, but still manageable
3 - SEVERE very frequent, and very disturbing
4 - EXTREME near constant, and disabling distress/frustration

5. Resistance Against Obsessions

• How hard does your child try to stop the thoughts or ignore them?

(Only rate effort made to resist, not success or failure in actually controlling the obsessions. How much your child resists the obsessions may or may not correlate with their ability to control them. Note that this item does not directly measure the severity of the intrusive thoughts; rather it rates a manifestation of health, i.e., the effort the patient makes to counteract the obsessions. Thus, the more your child tries to resist, the less impaired is this aspect of his functioning. If the obsessions are minimal, your child may not feel the need to resist them. In such cases, a rating of "0" should be given.)

0 – NONE makes an effort to always resist, or symptoms so minimal doesn't need to actively resist.

1 - MILD tries to resist most of the time
2 - MODERATE makes some effort to resist
3 - SEVERE yields to all obsessions without attempting to control them, but does so with some reluctance
4 – EXTREME completely and willingly yields to all obsessions

6. Degree of Control Over Obsessive Thoughts

• When your child ties to fight the thoughts, can your child beat them?
• How much control do your child have over the thoughts?

(In contrast to the preceding item on resistance, the ability of your child to control his obsessions is more closely related to the severity of the intrusive thoughts.)

0 - COMPLETE CONTROL
1 - MUCH CONTROL usually able to stop or divert obsessions with some effort and concentration.
2 - MODERATE CONTROL sometimes able to stop or divert obsessions
3 - LITTLE CONTROL rarely successful in stopping obsessions, can only divert attention with difficulty
4 - NO CONTROL experienced as completely involuntary, rarely able to even momentarily divert thinking

Child Response(s) If Present:

_____

4. Have the child participant leave the room. Ask parent to fill out **CY-BOCS-PR (Altered)**

CY-BOCS-PR (Altered, items 7-11)

"Your child will now be asked to step out of the room. I am now going to ask you to rate the characteristics of each of the following items over the prior week up until, and including, the time of this interview. In turn, the scores here reflect the average of each item for the entire week, unless otherwise specified."

Rate the characteristics of each item over the prior week up until, and including, the time of the interview. Scores should reflect the average of each item for the entire week, unless otherwise specified. Here, your child will be asked to leave the room.

Severity Scale For Obsessions:

7. <u>Interference</u>:

- To what degree does your child's obsession interfere with everyday functioning? Areas such as: social, familial, and school-related.

0 - NONE
1 - MILD slight interference with social or school activities, overall performance not impaired
2 - MODERATE definite interference with social or school performance, but still manageable
3 - SEVERE causes substantial impairment in social or school performance
4 - EXTREME incapacitating

8. <u>Distress:</u>

- To what degree does your child's obsession seem to physically/emotionally distress them?

0 - NONE
1 - MILD infrequent, and not too disturbing
2 - MODERATE frequent, and disturbing, but still manageable
3 - SEVERE very frequent, and very disturbing
4 - EXTREME near constant, and disabling distress/frustration

9. <u>Frequency</u>:

- On average, how frequently does your child exhibit obsessional behaviors towards their object of interest?

0 - NONE
1 - MILD infrequent, and not too disturbing
2 - MODERATE frequent, and disturbing, but still manageable
3 - SEVERE very frequent, and very disturbing
4 - EXTREME near constant, and disabling distress/frustration

<u>10. Disturbance Scale For Obsessions:</u>

Resistance:

- How hard does your child try to resist obsessive thoughts towards their object of obsession?

(If the obsessions are minimal, the patient may not feel the need to resist them. In such cases, a rating of "0" should be given.)
0 – NONE makes an effort to always resist, or symptoms so minimal doesn't need to actively resist.
1 - MILD tries to resist most of the time
2 - MODERATE makes some effort to resist
3 - SEVERE yields to all obsessions without attempting to control them, but does so with some reluctance
4 – EXTREME completely and willingly yields to all obsessions

11. <u>Control</u>:

- How often does your child try to assert control over the obsessional thoughts they hold towards their object of obsession? How much control over these obsessional thoughts do you believe they possess?

0 - COMPLETE CONTROL
1 - MUCH CONTROL usually able to stop or divert obsessions with some effort and concentration.
2 - MODERATE CONTROL sometimes able to stop or divert obsessions
3 - LITTLE CONTROL rarely successful in stopping obsessions, can only divert attention with difficulty
4 - NO CONTROL experienced as completely involuntary, rarely able to even momentarily divert thinking

Ask the child to return to the room.

5. Have parent fill out the Cambridge University Obsessions Questionnaire (altered).

"I am now going to ask you about whether or not your child's obsession falls under certain domains. If "Yes", please specify.

CAMBRIDGE UNIVERSITY OBSESSIONS QUESTIONNAIRE (altered) Items 11-15

For each category of obsession, please tick whether your child has ever had an obsession in that category. If "YES", please specify the exact obsession(s).

11. MACHINES (how things work) e.g. computers, radios, TVs, washing machines, clocks, burglar alarms, etc.,
YES NO
If YES, please specify
_____
_____

12. SYSTEMS e.g. toilet flushing, drains, light switches, etc.,
YES NO
If YES, please specify
_____
_____

13. STRONGLY ATTACHED TO A PARTICULAR ITEM e.g. an article of clothing, a rag, a bottle top, etc.,
YES NO
If YES, please specify
_____
_____

14. FACTUAL INFORMATION e.g. writing, reading or memorising lists of things, writing letters, reading encyclopaedias, newspapers, etc.,
YES NO
If YES, please specify
_____
_____

15. OTHER: Please list any other obsessions which you do not feel are covered by the other categories
_____
_____

Child Response(s) if present:
_____

6. Have parent fill out Exact Content of Obsession section.

"Lastly, I am going to ask you about the exact content of your child's obsession."

EXACT CONTENT OF OBSESSION (Item 16)

16. Please mark off whether your child is obsessed with trains, clocks, or both.

- 1. Trains _____
- 2. Clocks _____
- 3. Both Trains & Clocks _____
- 4. Neither Clocks nor Trains _____

Child Response(s) if present:

_____

Appendix E

Table 2.

Correct answers and corresponding item numbers for the CAM-C Face task.

Item no.	File Name	Answers (correct answers for each item appears in the file name)			
61010721	0107202C1Vunfriendly	1. unfriendly	2. shy	3. worried	4. surprised
61010722	0107202S2Vunfriendly	1. kind	2. unfriendly	3. liked	4. afriad
61010723	0107202m4Vunfriendly	1. liked	2. sure	3. unfriendly	4. disgusted
61190091	1900903C2Vjealous	1. ashamed	2. ignoring	3. jealous	4. bored
61190092	1900903C3Vjealous	1. sorry	2. believing	3. embarrassed	4. jealous
61190093	1900903Y1Vjealous	1. jealous	2. disapointed	3. nervous	4. upset
61180021	1800201C4Vbothered	1. uncaring	2. bothered	3. gloomy	4.panicked
61180022	1800201S3Vbothered	1. sneaky	2. amused	3. bothered	4. bored
61180023	1800201C5Vbothered	1. keen	2. relieved	3. disbelieving	4. bothered
61030021	0300201C5Vamused	1. curious	2. interested	3. honest	4. amused
61030022	0300201C6Vamused	1. amused	2. relieved	3. sneaky	4. cheeky
61030023	0300201S5Vamused	1. sure	2. amused	3. keen	

Table 3.

Correct answers and corresponding item numbers for the CAM-C Voice task.

Item No.	File Name	Answers (correct answer for each item appears in file name)			
62010721	0107202P3Tunfriendly	1. unfriendly	2. disgusted	3. sure	4. hurt
62010722	0107202R1Tunfriendly	1. tired	2. unfriendly	3. shy	4. teasing
62010723	0107202Z5Tunfriendly	1. interested	2. cheeky	3. unfriendly	4. excited
62030021	0300201P3Tamused	1. unsure	2. amused	3. thinking	4. interested
62030022	0300201R2Tamused	1. excited	2. tempting	3. amused	4. impressed
62030023	0300201Z6Tamused	1. impressed	2. afraid	3. excited	4. amused
62180021	1800201P5Tbothered	1. disbelieving	2. bothered	3. liked	4. impressed
62180022	1800201R6Tbothered	1. bothered	2. affectionate	3. troubled	4. patient
62180023	1800201P3Tbothered	1. unsure	2. disgusted	3. bothererd	4. amused
62190091	1900903P5Tjealous	1. bossy	2. angry	3. hurt	4. jealous
62190092	1900903R2Tjealous	1. jealous	2. disappointed	3. proud	4. thinking
62190093	1900903V6Tjealous	1. teasing	2. jealous	3. proud	4. sure

Appendix F

Image 1. Vehicles/Animated Faces in The Transporters Intervention [Digital image]. (n.d.). Retrieved April 23, 2017, from http://www.thetransporters.com/about.html
Vehicles used in original The Transporters intervention (cable cars, a tractor, a chain ferry, a coach, two trams, and a funicular railway).

Appendix G

PARENTAL PERMISSION FORM FOR CHILD'S RESEARCH PARTICIPATION

Study Title: Obsession Matched Intervention Improves The Facial/Emotional Recognition Deficit in Asperger's Children

Principal Investigator:

Student Researcher:

IRB Study Number:

Your child is being asked to take part in a research study. This form has important information about the reason for doing this study, what we will ask your child to do, and the way we would like to use information about your child if you choose to allow your child to be in the study.

Why are you doing this study?

Your child is being asked to participate in a research study about obsessions and emotion recognition in Asperger's children. The purpose of the study is to investigate the relationship between obsessions and facial/emotional recognition in Asperger's Syndrome.

What will my child be asked to do if my child is in this study?

You will be asked to complete a variety of baseline measures, including tests that measure the presence of Autistic characteristics, obsessional characteristics, as well as the IQ of your child. Your child will be present during the completion of these measures, and able to contribute when they feel the need to. Your child will be asked to take a test that measures their facial/emotional recognition ability. Lastly, they will be instructed to watch a series of videos that are designed to be both child and Autism-friendly, over the course of four months. Parental participation is necessary during the viewing of each episode. Instructions will be given to you, regarding your participation. The parental participation here is minimal. These videos are meant to relay and teach facial/emotional recognition and understanding. During the viewing of these videos, eye-tracking technology will be utilized. Participation should take a total of 16 weeks and two days.

We would like to track your child's fixation durations as he watches the videos, to make sure that we accurately document all the information. The researchers will keep these recordings in a private and safe place, and they will only be used by researchers directly involved in this study. Results of these eye movements will be documented in the final document of this study.

Please indicate if you give permission for us to record your child's eye movements during the video viewing, at the end of this consent form. Eye movement tracking is required for participation in this study. If you do not wish for your child's eye movements to be recorded, it is not possible for your child to be in this study.

What are the possible risks or discomforts to my child?

Possible risks involved with participation in this study are mild at most. They might experience a proliferation of their obsessions/obsession like qualities, simply due to the questioning we must do around this subject. There is a possibility that they might become frustrated with their facial/emotional recognition deficit, due to the testing of this deficit. We do not expect

these risks to manifest, but it is important that we mention them beforehand. To the best of our knowledge, the things your child would be doing in this study have no more risk of harm than the risks of everyday life.

As with all research, there is a chance that confidentiality of the information we collect about your child could be breached – we will take steps to minimize this risk, as discussed in more detail below in this form.

What are the possible benefits for my child or others?

Your child is likely to have direct benefit from being in this research study. This study is designed to learn more about the relationship between obsessions in Asperger's Syndrome, and the facial/emotional recognition deficit in Asperger's Syndrome. The study results may possibly be used to help other people in the future. The possible benefits to your child from this study include an improvement in social skills and their recognition of social/facial/emotional cues.

How will you protect the information you collect about my child, and how will that information be shared?

Results of this study may be used in publications and presentations. Security measures will be in place to protect your child's anonymity in this study. Their names, faces, and voices will not be used in the final publication of this study.

If we think that your child intends to harm him/herself or others, we will notify the appropriate people/agencies with this information.

Financial Information

Participation in this study will involve no cost to you or your child. Your child will not be paid for participating in this study.

What are my child's rights as a research participant?

Participation in this study is voluntary. Your child may withdraw from this study at any time -- you and your child will not be penalized in any way or lose any sort of benefits for deciding to stop participation.

If your child decides to withdraw from this study, the researchers will ask if the information already collected from your child can be used

Who can I contact if I have questions or concerns about this research study?

If you or your child have any questions, you may contact the researchers at _____

Parental Permission for Child's Participation in Research

I have read this form and the research study has been explained to me. I have been given the opportunity to ask questions and my questions have been answered. If I have additional questions, I have been told whom to contact. I give permission for my child to participate in the research study described above and will receive a copy of this Parental Permission form after I sign it.

Consent for child to participate in this study:

Initial one of the following to indicate your choice:

_____ (initial) I agree to allow my child to participate in the research study described above.

_____ (initial) I do not agree to allow my child to participate in the research study described above.

Consent for parent to participate in this study:

Initial one of the following to indicate your choice:

_____ (initial) I agree to participate in this study by completing baseline measures with my child. I also agree to participate in this study by aiding my child during the viewing of the distributed videos.

_____ (initial) I do not agree to in this study by completing baseline measures with my child. I also agree to participate in this study by aiding my child during the viewing of the distributed videos.

Consent to eye movement tracking during the viewing of videos:

Initial one of the following to indicate your choice:

_____ (initial) I agree to allow my child's eye movements to be recorded during the viewing of the distributed videos.

_____ (initial) I do not agree to allow my child's eye movements to be recorded during the viewing of the distributed videos.

_____ _____

Parent/Legal Guardian's Name (printed) and Signature Date

_____ _____

Name of Person Obtaining Parental Permission

_____

Date

Appendix H

Table 4.
Expected means and cut-off scores for all baseline measures.

Test/Quotient	**Expected Mean**	**Cut-off score for inclusion**
AQ-Child	115	76
CAST	21.08	15
WISC-V	98.3	963
Parental Questionnaire	24	21

Note. Participants from the initial sample who do not meet these cut-off scores for inclusion will not be recruited for the study.

Appendix I

Table 5.
Order of episodes/emotions taught during 16 week intervention viewing period

Week 1	**Week 2**	**Week 3**	**Week 4**
unfriendly	jealous	amused	bothered
jealous	unfriendly	bothered	unfriendly
amused	bothered	unfriendly	jealous
bothered	amused	jealous	amused

Appendix J

Proposed Timeline for Procedure and Data Collection

Recruitment:
- 2-3 weeks
- Recruit at least 80 male subjects from the Anderson Center for Autism in New York, that are obsessed with either clocks or trains.

↓

Completion of baseline measures for inclusion:
- 1 day
- Participants and their parents come into a kid-friendly lab setting to complete the CAST, ASQ, WISC-V, and the Parental Questionnaire
    - *Data collection:* Collect data for baseline measures above. Contact participants who meet the criteria and notify them of the date they need to return to the lab. Contact participants who do not meet the criteria and notify them that they won't be included in the study.

↓

Administration of CAM-C (altered) pre-intervention:
- 1 day
- Participants return to the kid-friendly lab setting to complete the CAM-C (altered).
    - *Data collection:* Collect pre-intervention CAM-C (altered) score for all participants.

↓

Administration of *The Transporters* DVD and Tobi Pro X2-60 eye-tracker to participants in randomly assigned conditions:
- 1 day, same day as the administration of CAM-C (altered) pre-intervention. DVDs are administered after test is taken.
- Participants receive their assigned *The Transporters* DVD set.

↓

16 week intervention period:

- 16 weeks
- Participants view their assigned episodes of *The Transporters*, once a week, for 16 weeks. They are also given simple instructions on how to install and turn on the Tobi Pro X2-60 eye-tracker.

Administration of the CAM-C (altered) post-intervention:

- 1 day
- Participants return to the kid-friendly lab setting to complete the CAM-C (altered) once more.
    - *Data collection:* Collect post-intervention CAM-C (altered) score for all participants.

Appendix K

Debriefing Form

Thank you for participating in this study! We hope you enjoyed the experience. This form provides background about our research to help you learn more about why we are doing this study. Please feel free to ask any questions or to comment on any aspect of the study.

You have just participated in a research study conducted by _____

Purpose of this study:
You were told that the purpose of this study was to investigate the relationship between obsession and emotion recognition in children with Asperger's Syndrome, In actuality, we were interested in the possible benefits of an highly individualized obsession-specific intervention. This intervention aims to improve the social/emotional/facial recognition deficit in children with Asperger's Syndrome. To protect the integrity of this research, we could not fully divulge all the details of this study at the start of the procedure.

As you know, your participation in this study is voluntary. If you so wish, you may withdraw after reading this debriefing form, at which point all records of your participation will be destroyed. You will not be penalized if you withdraw.

You may keep a copy of this debriefing for your records.

If you have questions now about the research, please ask. If you have questions later, please e-mail _____. If, as a result of your participation in this study, you experienced any adverse reaction, please contact _____.

Thank you again for your participation.

Appendix L

Budgeting Proposal

Job Title (# of personnel needed)	Pay/hr	Hours Needed	Total Cost
Clinician (8)	$50	15	$6,000
Research Assistant (20)	$15	2	$600

Note. Numbers in parentheses indicate the total amount of personnel needed for the listed job title.

Apparatus/Material	Individual Cost	Amount Needed	Total Cost
Tobii Pro X2-60 Eye Tracking Technology	$11,610	80	$928,800
Tobii Pro X2-60 Eye Tracking Software	$8,000	80	$64,000
WISC-V Complete Kit - Hard Case	$1,282.70	20	$25,654
The Transporters Intervention DVD	$65	1	$65

Space Needed	Total Number of Days Space is Needed	Cost per Day	Total Cost
Kid-Friendly Lab Setting	3	$2,500	$7,500
Data/Results Computation Lab	10	$1,500	$15,000

Total Cost for Personnel, Materials, Measures, Labs, and Technology
$1,047,619